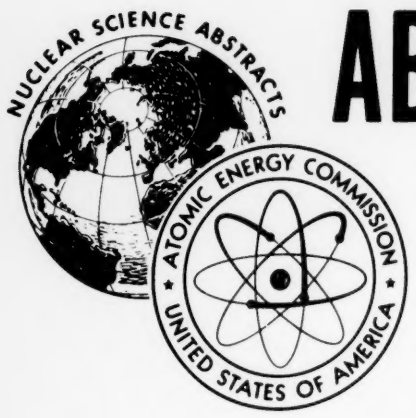
NUCLEAR SCIENCE ABSTRACTS



Volume 27 Number 2

Abstracts 2308-4917

January 31, 1973

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separation by ion exchange and complex-formation elution, 25:251(P)
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complexes with cobalt(III) and rhodium(III) chlorides, radiation effects on labeled, thermal-neutron, 25:137
TRITIUM
content in Cattaraugus Creek near West Valley Processing Plant, July through Dec. 1969, 25:258 (DOCKET-50201-48)
content in Cattaraugus Creek near West Valley Processing Plant, Jan. to July 1970, 25:259 (DOCKET-50201-49)
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Volume 27, Number 2, January 31, 1973

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstract 2386.

2308 (EUR-4894) PERFORMANCE OF MICROBALANCES. Brulmans, J.; Van Der Eijk, W.; Moret, H. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Nov 1972. 24p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 40.-.

In the standardization of radioactive solutions the size of the sample is determined by weighing. These mass determinations must be very accurate in order not to be the limiting factor in the standardization accuracy. Upon instigation of a working group on micro-weighings, created by the Bureau International des Poids et Mesures, several microbalances were tested on their performance when applying different weighing methods. The best accuracy which may be obtained with commercial balances is ±2 to 3 μg on solid samples, when the substitution method with external calibrated weights is applied. (auth)

Activation and Nuclear Reaction Procedures

Refer also to abstract 2426.

2309 (BNWL-SA-4455) NEUTRON ACTIVATION TECHNIQUES FOR THE MEASUREMENT OF TRACE METALS IN THE MARINE ENVIRONMENT. Robertson, D. E. (Battelle Pacific Northwest Labs., Richland, Wash.); Carpenter, R. (Washington Univ., Seattle). 29 Sep 1972. Contract AT(45-1)-1830. 71p. Dep. NTIS.

The technology and applications of neutron activation analysis (NAA) for the measurement of trace metal constituents in the marine environment are described. The contents are organized to indicate which trace elements can normally be measured by nondestructive INAA in the five matrices considered (fresh water, seawater, marine organisms, sediments, and atmospheric particulates) and, then when necessary, the chemistry required for preconcentrations and separations is provided. Emphasis is placed on the measurement of the most potentially hazardous trace metals Hg, Cd, Cu, Ag, As, Sb, Cr, Se and Zn. Lead and Sn are not included since NAA is not a sensitive method for these elements. (101 references) (auth)

2310 (TID-26207) NSF BASELINE STUDIES AT THE UNIVERSITY OF CALIFORNIA AT IRVINE. Kishore, Raj; Guinn, V. P. (California Univ., Irvine. Dept. of Chemistry). 1972. 13p. Dep. NTIS.

Neutron activation analysis was used to quantitatively determine trace amounts of mercury, selenium, and zinc in marine biological samples, including tuna, dolphin, shark, marlin, sea bass, fur seal, whale, and giant kelp. (D.H.M.)

2311 (Y-DA-4819) MINICOMPUTER IN THE ANALYTICAL LABORATORY AT Y-12. Stephens, A. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 19 Oct 1972. Contract W-7405-eng-26. 25p. (CONF-721025-9). Dep. NTIS.

From 16th conference on analytical chemistry in nuclear technology; Gatlinburg, TN. (24 Oct 1972).

Over the past few years minicomputers have become an integral part of several analytical instruments in the Oak Ridge Y-12 Plant. An overview of these applications is presented including use with a Quantometer (emission spectrograph), x-ray activation, neutron activation, spark source mass spectrometer, nuclear magnetic resonance, vacuum x-ray spectrometer, thermal ionization mass spectrometer, pole figure goniometer, electron microprobe, and a thermal diffusivity apparatus. General features of each system are discussed with major emphasis on unique items such as solution to RF noise problems on the Quantometer, telecommunications interface on the neutron activation instrument, and the use of a higher level language in 4 K (12 bit words) of core memory on the x-ray absorption instrument. (J.G.B.)

2312 DETERMINATION OF HYDROGEN CONTENT IN LIQUID AND SOLID SAMPLE BY COPPER WIRE ACTIVATION. Ibarra, H. H.; Gatchalian, G. R. (Philippine Atomic Energy Commission, Manila). Philipp. Nucl. J.; 2: No. 2, 236-41 (1970).

Fast or epithermal neutrons are thermalized by the hydrogen and the thermal neutrons detected using rings of copper wire placed around a cylindrical sample. The cadmium-filtered reactor neutrons from one edge of a light-water-moderated reactor core served as fast neutrons. The samples were uniformly irradiated at 1.0 kw reactor power for 15 min. After irradiation and one hour of cooling, the monitor and detector copper rings were taken out and γ-counted. A figure of merit was chosen as $R = C - Co/Co$ where C is the normalized detector count for a sample, and Co is the normalized detector count for a blank sample. The hydrogen contents of water, sucrose, benzoic acid, benzene, and coconut oil are shown. (M.C.G.)

2313 DISTRIBUTION OF CHLORINE, BROMINE, AND IODINE IN NORWEGIAN FOREST SOILS STUDIED BY NEUTRON ACTIVATION ANALYSIS. Lag, J. (Agricultural Coll. of Norway, Vollebekk); Steinnes, E. pp 383-95 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

Considerable attention has been paid to studies of the regional distribution of minor and trace elements in recent years. Neutron activation analysis, exhibiting high sensitivity for a great number of elements, clearly appears to be a useful tool in this connection. The distribution of the halogens chlorine, bromine and iodine in Norwegian forest soils is investigated. Simple neutron activation procedures based on Ge(Li) gamma spectrometry have been developed. In humus-rich samples the three elements can be determined by a purely instrumental method. Samples with higher mineral content require a radiochemical separation method preceding the activity measurements. A group precipitation of the silver halides following alkaline fusion of the sample has been found adequate for this purpose. (auth)

2314 USE OF SHORT-LIVED NUCLIDES ($T_{\frac{1}{2}} < 10$ s) FOR 14 MeV NEUTRON ACTIVATION ANALYSIS. Janczyszyn, J.; Loska, L.; Gorski, L. (Inst. of Nuclear Techniques, Krakow). Chem. Anal. (Warsaw); 17: No. 3, 703-15(1972).

Automatic activation analysis system for measuring short-lived radionuclides was constructed and tested. The system enables repeating of activation-counting cycle with the shortest transport time of the sample equal to 150 ms. The samples were transported pneumatically to the low-background counting place. The automatic

control based on the mechanical preset timers had the time basis of 0.1 s. Twenty radionuclides with half-lives ranging from 0.043 s to 7.4 s were produced by irradiation and their spectra were measured with the use of the system described. After introducing dead-time correction and appropriate normalization the table of experimental sensitivities was prepared. The possibility of using the following radionuclides: ^{197m}Au, ^{183m}W, ^{79m}Br, ^{207m}Pb, ^{203m}Pb, ^{114m2}In, ^{90m}Zr, ^{175m}Yb and ^{114m3}In in cyclic 14 MeV neutron activation analysis was established. (auth)

2315 DETERMINATION OF SERUM SELENIUM BY MEANS OF SOLVENT EXTRACTION COMBINED WITH ACTIVATION ANALYSIS. Hahn, H. K. J.; Williams, R. V.; Burch, R. E.; Sullivan, J. F.; Novak, E. A. (Veterans Administration Hospital, Omaha). J. Lab. Clin. Med.; 80: No. 5, 718-22(Nov 1972).

A method for the determination of selenium in serum was developed employing a combination of solvent extraction and neutron activation analysis. The loss of selenium by volatilization during digestion was minimized by use of a single oxidant at low temperature. Comparative analysis was performed to illustrate the efficacy of the method. (auth)

2316 MERCURY CONTENT OF COMMON FOODS DETERMINED BY NEUTRON ACTIVATION ANALYSIS. Tanner, James T.; Friedman, Melvin H.; Lincoln, David N.; Ford, Leonard A.; Jaffee, Max (Dept. of Health, Education, and Welfare, Washington, D. C.). Science; 177: No. 4054, 1102-3(22 Sep 1972).

The mercury contents in samples of flour, sugar, nonfat dry milk, potatoes, hamburger, chicken breast, shrimp, liver, eggs, and whole milk were determined by neutron activation analysis. The mercury was separated by anion exchange chromatography and precipitated as the sulfide. The mercury concentrations for all these foods were below 50 ppB. (auth)

2317 NEUTRON ACTIVATION STUDIES OF THE ROANOKE RIVER SYSTEM FROM ITS HEAD WATERS TO NIAGARA DAM. Mooney, Edward Jr. Blacksburg, Va.; Virginia Polytechnic Inst. and State Univ. (1972). 104p. University Microfilms Order No. 72-23,841.

Thesis.

An investigation of an unusually compact and well defined river system containing many environmental factors leading to water pollution was carried out by neutron activation analysis (NAA). Detailed measurements of the levels of sodium, chlorine, magnesium, manganese, calcium, aluminum, strontium and potassium were made above and below major effluent sources. Results indicate that, in the absence of non-organic sources of Na and Cl, the Na and Cl concentrations can be used to determine the increase in concentration of organic compounds and possibly the bacterial count in a water sample. (TSS) (Diss. Abstr. Int., B)

2318 NEUTRON ACTIVATION ANALYSIS OF DATURA STRAMONIUM TATULA SEEDS. Gupta, Mahabir P.; Gibson, Melvin R.; Filby, Royston H. (Washington State Univ., Pullman). Lloydia; 35: No. 2, 189-91(Jun 1972).

A method for determining potassium, manganese, sodium, chlorine, and copper in Datura stramonium (L) var. tatula Torrey seeds by neutron activation is described. (D.H.M.)

2319 TRACE ELEMENTS IN THE SEDIMENTS OF LAKE MENDOTA AND TROUT LAKE. Bors, James Joseph. Madison, Wis.; Univ. of Wisconsin (1972). 174p. University Microfilms Order No. 72-22,077.

Thesis.

Deep water sediments of Lake Mendota and Trout Lake were analyzed for the elements iron, manganese, barium, copper, arsenic, antimony, zinc, scandium, cobalt, chromium, lanthanum, cerium, samarium, europium, terbium, dysprosium, ytterbium, and lutetium. Analysis was by neutron activation, with some use of atomic absorption for chemical yield determination. (TSS) (Diss. Abstr. Int., B)

2320 SIMULTANEOUS NEUTRON ACTIVATION DETERMINATION OF SCANDIUM, COBALT, IRON, AND ZINC IN BIOLOGICAL MATERIAL USING A TOTAL ABSORPTION GAMMA SPECTROMETER. Khatamov, Sh.; Kist, A. A.; Maksudov, U. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 3, 68-71(1972). (In Russian).

An analytical procedure for determining Sc, Fe, Co, Zn, and Rb by activation analysis is described. Samples of kidney, blood, urine, etc. were irradiated for 20 to 50 hr ($\sim 10^{13}$ neutrons/cm^2·sec) with 15 to 20 days of cooling. The use of a total absorption γ spectrometer simplified the counting problem. The sensitivity of the method was for Sc, Co, Fe, and Zn: 5×10^{-8}%, 1×10^{-8}%, 1×10^{-8}%, 1×10^{-3}%, and 4×10^{-6}%. (K.S.W.)

2321 USE OF THE REACTION ^{6}Li(n,α)^{3}H WITH THERMAL NEUTRONS FOR LITHIUM DETERMINATIONS. Zverev, B. P.; Sumakhin, Yu. F. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 3, 82-3(1972). (In Russian).

A neutron activation method is described for the determination of Li, making use of the ^{6}Li(n,α)^{3}H reaction in the canal of a nuclear reactor, and employing a CsI(Tl) crystal as a detector of the tritium particles with suitable discrimination. The chief interfering element was ^{40}K, but with low concentrations of K, the error should not exceed 0.2%. The sensitivity of the method was 10^{-4} to 5×10^{-5}%. (K.S.W.)

2322 BACKGROUND REDUCTION IN ACTIVATION ANALYSIS OF GEOLOGICAL SAMPLES. Sagar Kshira, T. V. S. R.; Sriramadas, A.; Lakshminarayana, V. (Andhra Univ., Waltair, India). Curr. Sci. (India); 41: No. 19, 699-700(5 Oct 1972).

A cylindrical cast iron shield with an axial hole of 4" in diameter was used to reduce the background before using the equipment in the activation analysis of geological samples. The level of background at all energies except 640 KeV is tolerable for this type of analysis. The reduction in the background at 640 KeV is about 14. It appears that the peak at 640 KeV may partly be due to the radon content in air, which is not removed to a great extent in the shielded arrangement. (D.H.M.)

2323 NUCLEAR ACTIVATION ANALYSIS. Albert, Philippe (CEN de Saclay, Gif-sur-Yvette, France). Energ. Nucl. (Paris); 14: No. 3, 168-76(1972). (In French).

The radioisotopes used in activation analysis are produced by interacting neutrons, photons, or charged particles with matter. The different steps used in this type of analysis are described. The advantages of the different methods of activation are indicated together with the different fields of application. Examples of scientific and technical applications in university and industrial laboratories are presented. (France)

2324 EXTRACTION AND SEPARATION OF ANTIMONY III AND V FROM SULFURIC ACID MEDIA BY NONPOLAR SOLVENTS. Alian, A.; Sanad, W. (Atomic Energy Establishment, Cairo). Radiochim. Acta; 17: No. 3, 158-64(Oct 1972).

The extraction of Sb(III) and Sb(V) from H_2SO_4 solutions by benzene, toluene, xylene, cyclohexane, nitrobenzene, kerosene, chloroform, and carbon tetrachloride was investigated. Sb(III) may be selectively extracted and separated from Sb(V) from ~10 M H_2SO_4 by benzene, toluene, or xylene. Sb(III) and Sb(V) may be also separated from each other by coextraction from 8 to 10 M H_2SO_4 by nitrobenzene, followed by the selective stripping of Sb(III) from the solvent by 1 to 2 M H_2SO_4. Both Sb(III) and Sb(V) are well extractable from $\geq$ 14 M H_2SO_4 by the first 3 solvents. The effect of water-miscible alcohols and acetone on the extraction of Sb(III) and (V) by some of these solvents from H_2SO_4 media was studied. The presence of these alcohols and acetone makes possible the extraction of Sb(III) and (V) from solutions of lower sulfuric acid molarity. This can be used in activation analysis for antimony. (auth)

2325 RADIOACTIVATION ANALYSIS OF ARSENIC. COMMUNICATION 2. EXTRACTION-CHROMATOGRAPHIC SEPARATION OF MACRO- AND MICRO-ELEMENTS. Kuz'min, N. M.; Vlasov, V. S.; Bokova, T. A. Zh. Anal. Khim.; 27: No. 9, 1807-10(Sep 1972). (In Russian).

Extraction behavior of Au(III), Fe(III), Ga, and In in the n-decanol–hydrochloric acid system was suggested for calculating elution curves for separation of the elements by eluents of different composition. An extraction-chromatographic method for separation of Au(III), Fe(III), Ga, and In was suggested for radioactivation analysis of arsenic. The sensitivity of a determination is between 10^{-6} to 10^{-8}% depending on the element determined. (auth)

Chemical and Spectral Procedures

Refer also to abstracts 2383 and 2631.

2326 (AAEC/E-237) COMPARATIVE SURVEY OF METHODS FOR THE DETERMINATION OF URANIUM IN ORES. Florence, T. M.; Pakalns, P.; Dale, L. S. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug 1972. 23p. Dep. NTIS (U. S. Sales Only).

Results are given for an interlaboratory comparison of methods for the determination of uranium in ores. Four different uranium ores were carefully prepared and samples distributed to eleven participating laboratories. The ores were analyzed by several techniques, including spectrophotometric, fluorimetric, x-ray fluorescence, radiometric, and titrimetric procedures. Statistical analysis of the results showed that there was no significant difference between the uranium values found using spectrophotometric, fluorimetric, or x-ray fluorescence methods. (auth)

2327 (HEDL-SA-432) ANALYTICAL CHEMISTRY OF BORON CARBIDE. Stromatt, R. W. (Hanford Engineering Development Lab., Richland, Wash.). 11 Sep 1972. Contract AT(45-1)-2170. 13p. (CONF-721025-11). Dep. NTIS.

From 16th conference on analytical chemistry in nuclear technology; Gatlinburg, TN. (24 Oct 1972).

A program was initiated to implement and document procedures for the chemical analysis of boron carbide absorber pellets. The analytical procedures include compositional and impurities characterization, and in general these procedures are conventional. In the compositional analysis, total boron, total carbon, and isotopic content are determined. The total boron is determined by a potentiometric titration after the boron carbide is decomposed by fusion with sodium carbonate. Total carbon is determined gravimetrically as CO_2 after the sample is ignited in an oxidizing atmosphere. The isotopic content is determined by mass spectrometry using an on-filament fusion technique. In the impurities analysis, soluble carbon, soluble boron, fluoride, chloride, metal impurities, gas release, and water are determined. The soluble carbon is determined manometrically as CO_2 produced by a reaction of the sample in an oxidizing solution. In the soluble boron determination, samples are refluxed with dilute solutions of HNO_3 and HCl, and the extracted soluble boron is measured by potentiometric titration. Fluoride and chloride, after separation from the sample by pyrohydrolysis, are measured by specific ion electrode potentiometry and coulometry respectively. Metal impurities are determined by emission spectrography. The gas release is determined manometrically after the sample is heated to 1000°C. The water is measured coulometrically while heating the sample at 400°C. The procedures are described. (J.G.B.)

2328 (UCID-16114) CHEMICAL ANALYSES OF PRESHOT SAMPLES FROM THE RIO BLANCO EXPERIMENT. Hill, J. H. (California Univ., Livermore. Lawrence Livermore Lab.). 30 Aug 1972. Contract W-7405-Eng-48. 13p. (PNE-RB-30). Dep. NTIS.

Chemical assays of preshot samples taken from the Rio Blanco emplacement hole RB-E-01 are reported. The Rio Blanco rock contains less nongaseous hydrocarbons than rock from either Gasbuggy or Rulison. The carbonate content is also generally lower in Rio Blanco than in either Gasbuggy or Rulison. However, assays on 22 sections from Core #4 (6435 to 6457 ft) show a very uneven distribution of carbonates. (auth)

2329 AMPULE METHOD OF TRANSFORMING HYDROCARBONS INTO CO_2 TO BE USED FOR MASS-SPECTROMETRIC ISOTOPIC ANALYSIS OF HYDROCARBONS IN THE NATURAL RANGE. Nitzsche, H. M.; Waurick, U.; Maass, I. (Zentralinstitut fuer Isotopen- und Strahlenforschung, Leipzig). Isotopenpraxis; 8: No. 3, 114-16(Mar 1972). (In German).

Hydrocarbons are filled through a vacuum system into 10 ml ampules containing approximately 5g CuO. The ampules are then sealed and the hydrocarbons oxidized at 640°C. Following oxidation, the purified CO_2 is placed in sample tubes, which are closed by melting for isotope analysis by mass spectrometry. Significant advantages of the method are short time requirements for routine analysis and the possibility that it can be used not only for isotope analysis of carbon but also for that of nitrogen. For the latter purpose, the CO_2 is frozen out under vacuum and the nitrogen is pumped into sample tubes. (H.B.G.)

2330 COMPLEX FORMATION OF TECHNETIUM, RHENIUM, AND MOLYBDENUM WITH TOLUENE-3,4-DITHIOL AND ITS ANALYTICAL APPLICATION. Koyama, M.; Emoto, K.; Kawashima, M.; Fujinaga, T. (Kyoto Univ.). Chem. Anal. (Warsaw); 17: No. 3, 679-90(1972).

A fundamental study was performed on the complex formation of technetium with toluene-3,4-dithiol (tdt) in connection with those of molybdenum and rhenium. It was found that two kinds of technetium complexes, one is green and the other red, are formed in an equilibrium which is dependent on the acid concentration, reaction time, temperature and the molar ratio of technetium to the reagent. Profound effects of solvents such as alcohols and ketones on the color of the green complexes of the three elements were observed. However, solvents such as hydrocarbons, halogenated hydrocarbons and esters exhibited little effect on the spectra at room temperature. On the basis of these observations, a spectrophotometric method for the determination of these elements subsequent to the solvent extraction is described. Also, a simultaneous determination method of technetium and rhenium or molybdenum is presented. Molecular weight determinations and analyses of metal ions in complexes revealed that green complexes of those elements are monomeric, whereas red ones are polymeric, dimeric for molybdenum and dimeric or tetrameric for technetium respectively. (auth)

2331 DETERMINATION OF OXYGEN IN Te, As, Sb, AND Re BY REDUCTION WITH HYDROGEN. Lahl, W.; Fischer, W. (Research Inst. for Non-Ferrous Metals, Freiberg, Ger.). Chem. Anal. (Warsaw); 17: No. 3, 669-74(1972). (In German).

A method for the determination of oxygen in arsenic, tellurium, antimony, and rhenium, by reduction with hydrogen is described. The determination of water formed as a result of the reduction of oxide phase was carried out by titration with specially diluted K. Fischer's reagent. Wrapping in a metal foil was applied to reduce evaporation of the sample. Tin or lead foil could be used in the case of arsenic, and lead foil was the best for tellurium. Wrapping in the foil was not necessary for antimony and rhenium because of their low vapor pressure. Best conditions for the reaction were established on the basis of tests with appropriate oxides. Both compact and powdered samples, containing, depending on material, from 0.0005 to 9% of oxygen by weight, were examined. (auth)

2332 STUDY ON THE PROPERTIES AND ANALYTICAL APPLICATIONS OF COMPOUNDS OF CHLOROPROMAZINE AND PROMAZINE WITH THIOCYANATE COMPLEXES OF URANIUM(VI). Basinska, H.; Tarasiewicz, M. (Copernicus Univ., Torun, Poland). Chem. Anal. (Warsaw); 17: No. 3, 469-78(1972).

Chloropromazine (CPM) and promazing (PM) hydrochlorides react in an acid medium with uranium(VI) thiocyanate complexes, forming yellow compounds of the formulas: $(CPM \cdot H)_2[UO_2(SCN)_4]$ and $(PM \cdot H)_2[UO_2(SCN)_4]$ respectively. These compounds are fairly well soluble in chloroform but sparingly soluble in water. This property was exploited for the elaboration of an extractive-colorimetric method for the determination of uranium(VI). The method consists in extraction of the above mentioned compounds with chloroform from aqueous medium (C_{HCl} = 0.1 M, C_{NH_4SCN} = 0.3 M) followed by measurement of absorbance of the yellow extract at λ = 400 nm. The error amounted to ±2% in the concentration range of 20 to 200 μg U(VI)/ml. The time of analysis was approximately 20 minutes. The following ions: Na^+, K^+, Ca^{2+}, Cd^{2+}, Pb^{2+}, Zn^{2+}, Mn^{2+}, Ni^{2+}, Al^{3+}, Cl^-, CH_3COO^-, SO_4^{2-}, tartrates, and citrates (even in 30-fold excess) do not interfere with the determination, while Co^{2+}, Cu^{2+}, Bi^{3+}, Fe^{3+}, Ti^{4+}, Mo^{6+}, W^{6+}, oxalate, and phosphates do interfere. The method was applied to the determination of uranium in uranium ore. (auth)

2333 DETERMINATION OF TRACE AMOUNTS OF TELLURIUM BY SOME BASIC TRIPHENYLMETHANE DYES. Ramanauskas, E.; Zilenaite, M. Liet. TSR Aukst. Mokyklu Mokslo Darb., Chem. Chem. Technol.; No. 12, 27-32(1970). (In Lithuanian).

The reactions of $[ReI_6]^{2-}$ with methyl violet (I), brilliant green (II), malachite green (III), Blue Basic Turquoise (IV), and Rhodamine Zh (V) were studied in HCl medium. Photometric methods for determination of traces of Te^{4+} with the triphenylmethane dyes were developed. Ions that form iodide complexes or oxidize I^-, and also Ag^+, Pb^{2+} and Hg^+, which form insoluble iodides and chlorides, interfered in determination of Te with I-V; Ni, Co, Zn, SO_4^{2-}, CO_3^{2-}, NO_3^-, and PO_4^{3-} did not interfere. (Selenium-Tellurium Abstr.) (TSS)

2334 RHENIUM ANALYSIS BY SURFACE IONIZATION-ISOTOPE DILUTION METHOD. Walker, R. L. (Oak Ridge National Lab., Tenn.). J. Mass Spectrom. Ion Phys.; 10: No. 2, 207-9(Dec 1972).

A method for determining rhenium in rhenium–tungsten alloys containing 3 to 25 wt % rhenium by surface ionization from a hot tungsten filament and isotope dilution is described. The optimum sample size is about 10 μg and the expected standard deviation is ±1 to 2%. (D.H.M.)

2335 SPECTROPHOTOMETRIC STUDY OF THE REACTION OF AMERICIUM AND CURIUM WITH ARSENAZO III. Milyukova, M. S.; Myasoedov, B. F.; Ryzhova, L. V. Zh. Anal. Khim.; 27: No. 9, 1769-75(Sep 1972). (In Russian).

The reaction of americium(III) and curium(III) with arsenazo III was studied spectrophotometrically. The effect of pH, solution composition, content of alcohol, and some cations and anions on the absorption of light by the complex compounds of americium and curium with arsenazo III was investigated. Americium(III) and curium(III) react with arsenazo III in aqueous and aqueous-alcohol solutions with the formation of complexes of two types, MeR and MeR_2. The molar extinction coefficients for the MeR_2 complexes are 8.4×10^4 and 12.5×10^4 for americium and 8.5×10^4 and 14.0×10^4 for curium in aqueous and aqueous-alcohol media, respectively. The method allows down to 0.01 μg/ml of americium and curium to be determined. A spectrophotometric method combined with a radiometric one is suggested for determining americium in the presence of curium without its preliminary separation. (auth)

2336 ARSENITOMETRIC DETERMINATION OF DITELLURATOCUPRATE(III). Rozovskii, G. I.; Shimkyavichyute, G. S.; Norkus P. K. (Inst. of Chemistry and Chemical Technology, Vilnyus, USSR). Zh. Anal. Khim.; 27: No. 9, 1764-8(Sep 1972). (In Russian).

Potentiometric methods were worked out for direct and indirect arsenito-iodometric determination of ditelluratocuprate (III) in a strongly alkaline medium. Conditions for obtaining ditelluratocuprate (III) by means of $K_2S_2O_8$ were found; a method for quantitative control of a content of peroxidisulfate in such solutions is suggested. (auth)

2337 POLAROGRAPHIC CATALYTIC CURRENTS IN SOLUTIONS OF Mo(VI) , CHLORATE IONS AND CERTAIN HYDROXY ACIDS. Chikryzova, E. G.; Kiriyak, L. G. (Inst. of Chemistry, Kishinev). Zh. Anal. Khim.; 27: No. 9, 1747-53(Sep 1972). (In Russian).

Polarographic catalytic currents in the Mo(VI)–$KClO_3$–H_2A system (H_2A–malic, tartaric or trihydroxyglutaric acid) were investigated. The effect of temperature, pH, ionic strength as well as $KClO_3$, H_2A, and Mo(VI) concentrations in i_k was studied. The hydroxy acids enumerated cause exaltation of the catalytic current due to the formation of a surface-active intermediate complex, $Mo(V)A(ClO_3^-)$. A scheme of reactions proceeding in volume and on an electrode was suggested. The effect of some metals on i_k was studied and a possibility was shown for determining small amounts of Mo(VI) by the catalytic current in the presence of trihydroxyglutaric acid. (auth)

2338 EXTRACTION-PHOTOMETRIC DETERMINATION OF NIOBIUM(V) BY REACTION WITH PYROCATECHOL AND THENOYLTRIFLUORACETONE. Savrova, O. D.; Gibalo, I. M.; Lobanov, F. I. (Moscow State Univ.). Anal. Lett.; 5: No. 10, 669-73(1972).

The possibility of formation of mixed complex compound niobium(V)–pyrocatechol (PC)–thenoyltrifluoracetone (TTA) was shown. Optimum conditions for the formation of such a compound were found (7.5 M HCl, 0.3 M TTA, 0.4 M PC) and the molar ratio Nb(V) : PC : TTA = 1 : 2 : 2 was established by the equilibrium shift method. The absorption spectrum of the chloroform extract of the Nb–PC–TTA compound has a maximum at 414 nm, $\epsilon = (7.7 \pm 0.2) \times 10^3$. The influence of other ions on extraction–photometric determination of niobium(V) with PC and TTA is discussed. (auth)

2339 USE OF A TENSAMMETRIC WAVE FOR THE END-POINT DETECTION IN CHELATOMETRY. Nakagawa, G.; Nomura, T. (Nagoya Inst. of Tech., Japan). Anal. Lett.; 5: No. 10, 723-8(1972).

A new method for the end-point detection in complexometric titration using a tensammetric wave of organic reagents such as oxine and alizarin complexone (ALC) was studied. The tensammetric wave of these reagents disappears by their chelate formation and reappears by the liberation of free indicator during the exchange reaction between indicator chelate and EDTA. This mechanism is utilized for the end-point detection in complexometric titration of metals. Copper, cadmium, zinc, nickel, cobalt, manganese, lead, indium, thorium, and bismuth can be satisfactorily titrated within 1.5% relative error. Since the sensitivity of tensammetric wave is extremely high, very sharp end-point can be obtained for the titration of metals even in the concentration of 10^{-5}M. (auth)

2340 DISCHARGE CELL METHOD FOR OXIDATION-REDUCTION MICRO DETERMINATIONS. Borecky, O.; Stulik, K.; Zyka, J. (Karlova Univ., Prague). Chem. Listy; 66: No. 9, 975-8(Sep 1972). (In Czech).

The method of discharge cell is described, which was found suitable for microdetermination of some substances (hydrazinium sulfate, Fe^{2+}, I^-, and Tl^+) with cerium(IV) salt in 10^{-7} to 10^{-10} N concentration when a simple device was used. Working conditions were determined in which the presence of capacity current, which usually impairs some other electroanalytical methods, was kept down to the minimum. (auth)

2341 LOW-TEMPERATURE LUMINESCENT METHOD FOR DETERMINATION OF INORGANIC MICROADMIXTURES. Solov'ev, E. A.; Bozhevol'nov, E. A. (All-Union Scientific-Research Inst. of Chemical Reagents and Specially Pure Chemicals, Moscow). Zh. Anal. Khim.; 27: No. 9, 1817-27(Sep 1972). (In Russian).

Methods of determining inorganic microadmixtures (including Tl, Pb, Bi, Sb, Te, Se, As, Sn, Ga, In, and Ge) based on low-temperature luminescence of organic and inorganic substances are discussed. (auth)

2342 RATE OF EXTRACTION OF PYRAZOLINEDITHIOCARBAMINATES OF PLATINUM METALS. Busev, A. I.; Byr'ko, V. M.; Kvesitadze, A. G.; Simonova, V. N. (Moscow State Univ.). Zh. Anal. Khim.; 27: No. 9, 1802-6(Sep 1972). (In Russian).

The light absorption of solutions of compounds of platinum metals with aryl derivatives of pyrazolinedithiocarbaminates was studied. The rate of the extraction of the palladium(II), platinum(II), and ruthenium(III) compounds with 3-phenyl-5-(furfuryl-2)-pyrazolinedithiocarbaminate was investigated. The reagent is recommended for the selective and highly sensitive determination of palladium. The molar extinction coefficient is 83,000 at 380 nm. The determination of palladium in the presence of platinum at a ratio of 1 : 1000 and the extraction separation of palladium from ruthenium were carried out. (auth)

2343 POTENTIOMETRIC METHOD FOR DETERMINING GERMANIUM AND MOLYBDENUM(VI) IN NONAQUEOUS MEDIA. Kreshkov, A. P.; Kolosova, I. F.; Ogareva, M. B.; Dobronevskaya, Z. P. (Chemical-Technological Inst., Moscow). Zh. Anal. Khim.; 27: No. 9, 1797-1801(Sep 1972). (In Russian).

The composition and acidic-basic properties of compounds of molybdenum with antipyrine, diantipyrylmethane, diantipyrylpropylmethane, dimethylformamide in nonaqueous solutions were investigated. Compounds studied exhibit acidic properties in a chloroform–dimethylformamide mixture. A method was developed for quantitative determination of molybdenum(VI) and a mixture of molybdenum(VI) and germanium, based on potentiometric titration of the compounds with a benzene–ethanol solution. The method was tested on pure samples and some technological materials. (auth)

2344 FLUORESCENT COMPLEX OF HAFNIUM WITH MORIN IN HYDROCHLORIC ACID SOLUTIONS. Pilipenko, A. T.; Kukibaev, T. U.; Volkova, A. I.; Get'man, T. E. (Inst. of General and Inorganic Chemistry, Kiev). Zh. Anal. Khim.; 27: No. 9 1787-92(Sep 1972). (In Russian).

Spectrophotometric and luminescent characteristics were studied and optimum conditions were found (7N HCl) for the fluorescent complex of hafnium with morin. A ratio of Hf : MOR = 1 : 1 or the complex, formed in 7N HCl, was established by the method of continuous variations. The absorption and fluorescent spectra of the complex were measured under optimum conditions of its formation (λ^{ab}_{max} = 420 nm, λ^{f}_{max} = 507 nm). The quantum yield of the fluorescence, Q = 55%, the molar extinction coefficient, $Q_{436} = 16 \cdot 10^3$, and the magnitude of the objective criterion of sensitivity, $\epsilon \cdot Q = 8.8 \cdot 10^5$, were calculated. A fluorimetric method was developed for determining hafnium by morin in solutions containing equal amounts of hafnium and zirconium. Zirconium is preliminarily separated using the KU-2 cation exchanger. The sensitivity of the method is 0.04 μg Hf in 5 ml. (auth)

2345 SIMULTANEOUS DETERMINATION OF HALOGENS AND METALS IN ORGANIC SUBSTANCES. Volodina, M. V.; Khamed, M. D. (Moscow State Univ.). Zh. Anal. Khim.; 11: No. 9, 1828-33(Sep 1972). (In Russian).

A method is suggested for simultaneous determination of halogens and metals in organic substances. The method is based on the pyrolysis of a sample in the ammonia current at 800 to 900°C in the presence of ammonium sulfate. Halogen is determined by potentiometric titration of ammonium halide and the metal by a gain in the weight of the free metal, sulfide or sulfate. (auth)

Radiometric and Radiochemical Procedures

2346 (ANCR-1086) TECHNIQUE FOR ASSAY OF L-10 BOTTLES OF PLUTONIUM NITRATE. II. ADDITIONAL MEASUREMENTS AND CONSIDERATIONS. Cline, J. E.; Nieschmidt, E. B. (Aerojet Nuclear Co., Idaho Falls, Idaho). Sep 1972. Contract AT(10-1)-1375. 27p. Dep. NTIS.

Extensive assay measurements were recently made of L-10 bottles of plutonium nitrate using the technique previously described in IN-1433. The measurements were made at the ARCHO facility at Hanford. One hundred seven bottles were analyzed in this new series. As a result of these analyses and some further considerations of precisions of the technique, minor modifications were made to the previous analytical techniques. It is possible to determine the plutonium concentration through a measurement of the ratio of two gamma intensities and using this concentration, to determine the relative counting rate for the 413-keV γ ray and, hence, determine total ^{239}Pu. Total Pu, ^{238}Pu, ^{259}Pu, and ^{240}Pu are determined. (M.C.G.)

2347 (CEA-R-4352) SEPARATION AND ANALYSIS OF KRYPTON IN THE PRESENCE OF NITROGEN AND METHANE USING GAS PHASE CHROMATOGRAPHY. Charrier, Guy; Alba, Claude (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Oct 1972. 29p. (In French). Dep. NTIS (U. S. Sales Only).

The conditions for separating krypton from nitrogen and methane were determined for different adsorbents. The detection is carried out using a thermal conductivity cell, whose output signal can be amplified. The analytical parameters determining the accuracy (reproducibility, sensitivity, and calibration linearity) were studied with quantities of gas ranging from 2.10^{-3} cc to 0.1 cc. The association of an ionization chamber enables the stable and radioactive elements eluted to be measured. This technique can be used to measure high gas enrichments. (France)

2348 (TID–26199) REPORT OF ANALYSES OF WATER SAMPLES SUBMITTED TO SCRIPPS, NOVEMBER 1971, FOR THE LAKE MICHIGAN INTERCALIBRATION/INTERCOMPARISON PROGRAM (EIIP). Folsom, T. R.; Hodge, V. F.; Wong, K. M.; Hansen, N. (Scripps Institution of Oceanography, La Jolla, Calif. Soledad Lab.). 6 Apr 1972. Contract AT(04-3)-34. 7p. Dep. NTIS.

One sample (50 l) of contemporary Lake Michigan water was analyzed for ^{137}Cs, ^{134}Cs, and $^{239,240}Pu$. In this sample 0.058 ± 0.014 pCi (±1σ)/kg of ^{137}Cs was found; less than 0.005 pCi/kg of ^{134}Cs was detected, and 0.0007 ± 0.0003 pCi/kg of $^{239,240}Pu$ was found. One sample (18.1 kg) of Lake Michigan water to which radioisotopes were said to have been added was analyzed for the same three elements at somewhat higher concentrations. In this "spiked" sample 3.66 ± 0.10 pCi/kg of ^{137}Cs was found, 2.76 ± 0.08 pCi/kg of ^{134}Cs was found, and 0.0373 ± 0.0013 pCi/kg of $^{239,240}Pu$ was found. (auth)

2349 DETERMINATION OF NUCLEAR FUEL BURNUP ON THE BASIS OF A MASS SPECTROSCOPIC DETERMINATION OF THE CHANGE IN ISOTOPIC COMPOSITION OF THE FUEL DURING IRRADIATION. Krtil, Josef (Inst. for Nuclear Research, Rez, Czech.). Jad. Energ.; 18: No. 10, 325-9(Oct 1972). (In Czech).

Estimation of fuel burn-up from the change in its isotopic composition during fission is discussed. The conditions are outlined for using this method, and burn-up equations are given. Methods suitable for separating U and Pu from solutions of irradiated fuel are surveyed. (tr-auth)

2350 RADIOMETRIC AGES OF SELECTED HAWAIIAN CORALS. Hammond, Dale Alden. Honolulu, Hawaii; Univ. of Hawaii (1971). 177p. University Microfilms Order No. 72-24,372.

Thesis.

A new scheme for the separation of uranium and thorium from one another and from other interfering ions, especially calcium, aluminum, and iron was developed using mixed solvent systems and Biorad AG-1 X8 resin. The complete separation takes place in one column operation after an initial precipitation procedure to reduce the ionic strength of the solution such that it will be soluble in the mixed solvent system. An automatic elution and fraction collector was developed to further facilitate the ion exchange separation. This allows the entire separation to take place without operator attention after the initial set up. The elution system automatically changes elution reservoirs and controls the liquid level above the resin bed. The fraction collector allows collection in constant time, constant volume and constant number of drops modes and is especially convenient for ion exchange column developmental work. In the constant volume mode, provision is made to collect each elution fraction separately and with an absolute minimum of cross contamination. These systems were applied to the separation of uranium and thorium from corals from the island of Oahu, Hawaii. Computer programs were developed to load the alpha spectrometric data of these analyses as outputed on Teletype 8 level ascii code into a computer, plot a graph of the data, total the counts under each peak, and calculate the age of the sample. These resultant ages are discussed as to geologic implication. (Diss. Abstr. Int., B)

Separation Procedures

Refer also to abstracts 2462, 2467, and 2483.

2351 SEPARATION OF ^{99}Mo AND $^{186,188}Re$ THROUGH ION-ELECTRIC FOCUSING. Shvedov, V. P.; Semanov, G. N. (Leningrad Technological Inst.). Isotopenpraxis; 8: No. 3, 118-20 (Mar 1972). (In German).

The separation of Mo and Re was studied for concentration ratios Mo : Re from 1 : 1 to 100 : 1. If the Mo : Re ratio was higher than 80 : 1, the Re and Mo zones formed a confluent spot that was difficult to evaluate. The experiments proved the suitability of the method for separating small amounts of Re from large quantities of Mo up to a maximum ratio Mo : Re of 50 : 1 in concentrations of 0.5 mg/ml. Optimal separation conditions were as follows: separation time, 5 min; field strength, 38 V/cm; catholyte, 0.3 M EDTA; and anolyte 2M HNO_3. (H.B.G.)

2352 ANION EXCHANGE PAPER CHROMATOGRAPHIC SEPARATION OF METAL IONS. De, A. K.; Bhattacharya, C. R. (Visva-Bharati Univ., Santiniketan, India). Chem. Anal. (Warsaw); 17: No. 3, 609-13(1972).

Several metal ion mixtures containing three to six metal ions were separated on SB-2 anion exchange paper, using the developing systems containing 2-thenoyltrifluoroacetone (TTA) as a chelating agent and tri-n-butyl phosphate (TBP) as a solvating solvent in combination with lithium chloride and hydrochloric acid solutions. The separation of the metal ion mixtures was described in terms of their R_F values. The metal ion mixtures studied are: Ce, Nb, and La; Ce, Th, and Zr; V, Nb, and Ta; U, W, Mo, and Cr; W, V, Cr, and Fe; Zn, Hg, and Cd; Al, Cr, and Fe; Pd, Pt, Cu, and Ag; Tl, Al, In, and Ga; Co, Zn, Cu, Ni, Mn, and Fe; Sb, As, and Bi; and Sn, Sb, and As. (auth)

2353 EXTRACTION OF NITRIC ACID AND OF LANTHANIDES BY HEXABUTYLPHOSPHORIC TRIAMIDE. Gonnet, C.; Lamotte, A.; Porthault, M. (Univ., Lyon). Anal. Chim. Acta; 62: No. 1, 227-32(Nov 1972). (In French).

The distribution of water and of nitric acid between an aqueous phase and an organic phase of hexabutylphosphoric triamide (HBPT) was studied. The distribution of Tb and Tm in a 0.1 M solution of HBPT was determined as a function of the HNO_3 concentration; effects of the concentration of HNO_3 on separation coefficients for the lanthanides are reported. The stoichiometry of lanthanide–HBPT complexes extracted in studying the distribution of Eu, Tm, and Yb was also studied. (J.G.B.)

2354 EXTRACTION OF ZIRCONIUM AND HAFNIUM. II. THE EXTRACTION WITH BIDENTATE ORGANIC PHOSPHORUS COMPOUNDS. Bronzan, P.; Meider-Gorican, H. (Institut Rudjer Boskovic, Zagreb). J. Less-Common Metals; 29: 407-13(1972). (In German).

The extraction of zirconium and hafnium from perchloric acid and sulfuric acid solutions by bis-di-n-hexylphosphinylmethane, $(C_6H_{13})_2OPCH_2PO(C_6H_{13})_2$, and di-n-octyl 2-oxo-propanphosphonate, $CH_3COCH_2PO(OC_8H_{17})_2$, was studied. The dependence of the partition of the metals on the hydrogen, sulfate and perchlorate ion concentrations, and on the concentration of the ligands, was determined. The formation of the complexes $Me(OH)L_3$, $MeSO_4L_2$ and $Me(ClO_4)_4$, 2HL, [Me = Zr, Hf; HL = DHMP, DOOPP], is assumed. (auth)

2355 EXTRACTION OF MINERAL ACIDS AND TRANSITION METAL IONS BY DI(n-OCTYL)ARSENIC ACID (DOAA) IN CHLOROFORM. Olivares, Alberto Manuel. College Station, Tex.; Texas A and M Univ. (1972). 139p. University Microfilms Order No. 72-24,321.

Thesis.

The extraction of $HClO_4$, HCl, HBr, HNO_3, H_2SO_4, HI, and the metal ions Sc(III) in HCl solution, Ce(III), Eu(III), Ho(III), and Yb(III) in acetate buffered solutions by chloroform solutions of dioctylarsinic acid (DOAA), $(n\text{-}C_8H_{17})_2AsOOH$, was investigated. Scandium(III) was extracted from HCl solutions in the pH range 0.06 to 3.50, with E_a^o reaching a maximum value of 260 above pH 2. E_a^o was found to be second power dependent on the logarithm of the aqueous equilibrium $[H^+]$. The lanthanide ions studied extracted best in the pH range 5.0 to 7.5 from acetate buffered solutions. The maximum values of E_a^o were 8, 17 and 6 at pH 6.2, 6.6 and 7.5 for Yb, Ho and Eu, respectively. The log E_a^o for the lanthanides was found to be second power dependent on the logarithm of the aqueous equilibrium $[H^+]$. Reagent dependence studies showed that the log E_a^o for scandium was second power dependent on the logarithm of the uncomplexed concentration of dimeric $(DOAA)_2$. Unlike scandium, the log E_a^o for the lanthanides was found to be two and one-half power dependent on the logarithm of the uncomplexed concentration of dimeric $(DOAA)_2$. Water was coextracted only in the scandium systems. The extracted species are probably hexacoordinated. The formulas $[ScCl(H_2O)D_2(HD)_2]$ and $[MYD_2[HD)_3]$ are proposed [M = lanthanide(III) ion, HD = DOAA, D = $(C_8H_{17})_2AsO_2^-$, Y = OH or CH_3COO^-]. (TSS) (Diss. Abstr. Int., B)

2356 LEACHING OF MOLYBDENITE FROM THE BULK CONCENTRATES OF MOLYBDENITE-CONTAINING BISMUTHINITE. Whang, Yong K.; Park, Se Y.; Oh, Jae H. J. Korean Inst. Metals; 10: No. 1, 39-42(1972).

To investigate the effect of separation of molybdenite from the bulk concentrates of molybdenite-containing bismuthinite, leaching tests of molybdenum oxides were carried out by using caustic soda. These oxides were prepared from bulk concentrates by roasting at 600°C. Results obtained by leaching under normal pressure indicated that the leaching rate increased as MoO_3 content increased and Bi content decreased. Since the leaching rate depended on the weight ratio of MoO_3 to Bi, the bismuth content had a profound effect on the leaching of molybdenum oxides. However, the leaching rate of molybdenum oxides under the high

pressure and the high temperature showed the excellent leaching efficiency independent of the bismuth content. (Korean Sci. Abstr.)

2357 SUPPRESSION OF THE EXTRACTION OF MICROELEMENTS DURING THEIR REMOVAL FROM CHLORIDE SOLUTIONS IN THE PRESENCE OF GALLIUM. Zolotov, Yu. A.; Golovanov, V. I. (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Neorg. Khim.; 17: No. 6, 1717-20(Jun 1972). (In Russian).

The extraction of Tl(III), In, Zn, Co, and Sc (10^{-6} to 10^{-4} mole/l) from HCl solutions by highly polar organic solvents (e.g., 2,2'-dichlorodiethyl ether) and in the presence of large quantities of Ga was studied. The macroelement had a definite influence on the extraction of the microelements depending on their associated ions and their state in the extract. A suppression of Tl and In extraction was observed when they were present as the complex acids $HTlCl_4$ and $HInCl_4$. In the event that the microelement was extracted in a non-dissociating form in the extract (e.g., $ScCl_3$), then such suppression was not evident. (tr-auth)

2358 USE OF N-CINNAMOYLPHENYLHYDROXYL AMINE IN ANALYTICAL CHEMISTRY. COMMUNICATION 5. SEPARATION OF TITANIUM AND ZIRCONIUM FROM GALLIUM AND INDIUM. Ostroumov, E. A.; Kulumbegashvili, V. A. (Inst. of Oceanology, Moscow). Zh. Anal. Khim.; 27: No. 9, 1776-80 (Sep 1972). (In Russian).

A method was developed for the separation of titanium and zirconium from gallium and indium. The method is based on precipitation of titanium in 10N H_2SO_4 and zirconium in 1N H_2SO_4 with N-cinnamolyphenylhydroxylamine. The separation proceeds satisfactorily when a single precipitation is used. (auth)

2359 EXTRACTION OF TERBIUM WITH BIS(ETHYL 2-HEXYL) PHOSPHORIC ACID FROM MIXED MEDIA. Alian, A.; Born, H. J. (Technische Univ., Munich). Radiochim. Acta; 17: No. 3, 168(Oct 1972).

The extraction of trivalent rare earths as represented by terbium using DEHPA decreased considerably, as expected, in the presence of water-miscible organic additives in the aqueous phase. (M.C.G.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 2386, 2481, and 3971.

Chemical and Physicochemical Properties

Refer also to abstracts 3002, 3003, and 4355.

2360 (ANL-7923) CHEMICAL ENGINEERING DIVISION PHYSICAL INORGANIC CHEMISTRY SEMIANNUAL REPORT, JANUARY-JUNE 1972. Blander, M.; Cunningham, P. T.; Eberhart, J. G.; Feder, H. M.; Maroni, V. A.; Schnyders, H. C.; Veleckis, E.; Tevebaugh, A. D.; Vogel, R. C. (Argonne National Lab., Ill.). Aug 1972. Contract W-31-109-eng-38. 51p. Dep. NTIS.

Studies in several diverse areas of physical and inorganic chemistry are continuing. Accurate pressure-composition isotherms for the Li-H system at temperatures of interest to fusion-reactor technologists are reported. Working estimates of Sieverts' constants for deuterium and tritium dissolved in liquid lithium are calculated. Limits of superheat were measured for a variety of hydrocarbons including the normal alkanes, branched alkanes, cyclic hydrocarbons, normal unsaturated hydrocarbons, and some mixtures of these compounds. A promising approach to the quantitative estimation of limits of superheat of liquids from their equations of state is described. Vapor-phase chemical equilibria of metal halide systems typical of those used in the purification and recovery of certain metals were studied by laser-Raman spectroscopy. A nonempirical pair potential for argon is developed and used to accurately calculate thermodynamic and transport properties in the gas phase. (auth)

2361 (NP-19587) THERMODYNAMIC INVESTIGATIONS OF COMPLEX FORMATION OF THE LANTHANOID- AND SCANDIUM-DICARBOXYLATE SYSTEMS. Gardhammar, Goeran (Lund Univ. (Sweden)). 1972. 50p. (In Swedish). Dep. NTIS (U. S. Sales Only).

Thesis.

Complexes of rare earths and scandium with oxalate, iminodiacetate (IMDA), and ethylenediamin-N-N'-diacetate (EDDA) were studied. Complex formation and complex equilibriums were examined by potentiometric titration. This was possible because a-1 the complex forming ions (A) are corresponding bases to weak acids. For the Eu-IMDA system an equation of concentrations of different complexes was established. Constants were calculated by least square fit of potentiometrically measured values. Good agreement between equation and measured values was received due to the complexes MA_2^{3-2r}, MHA^{2+} and MH_2A^{3+} being present. For Pr, Ho, and Lu the same complexes are dominating as the same equation gives a good description of the potentiometrically measured values. For the EDDA-system, it was shown that the complexes MA^+, MA_2^-, MHA^{2+}, and MH_2A^{3+} are dominating. Consequently it was established that acidic complexes are present. The Ce-oxalate system has been studied with a solubility method. The complexes Ce Aj^{3-2j}, j = 1-4 are shown to be dominating. As measured values are described very well by the calculated equations, it is shown that complexes with more than one metal atom and hydroxycomplexes are not important between rare earths and these complex agents. (Sweden)

2362 TRENDS IN THE THERMODYNAMIC FUNCTIONS OF COMPLEXATION OF THE LANTHANIDE IONS WITH DIFFERENT LIGANDS AND THE DOUBLE-DOUBLE EFFECT IN THE ENTHALPY CHANGES. Fidelis, I. (Inst. of Nuclear Research, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 20: No. 6, 605-10(1972).

It is shown that four basic trends can be distinguished in the enthalpy and entropy changes of complex formation of lanthanides by a variety of ligands. These trends appear also in the enthalpies and entropies of consecutive complex formation with the same ligand. It is also demonstrated that the double-double effect, which consists in the stabilization of the f^3, f^4, f^{10}, and f^{11} configurations in addition to the f^0, f^7, and f^{14} configurations, exists in the enthalpies of complex formation of lanthanides. (auth)

2363 POTENTIAL ANTIRADIATION AGENTS. p-ANISYL-BUTYL DERIVATIVES OF S-2-AMINOETHYL HYDROGEN THIOSULFATE, 2-AMINOETHANETHIOL, THE CORRESPONDING DISULFIDE, AND THIAZOLIDINE. Westland, R. D.; Holmes, J. L. (Parke, Davis and Co., Ann Arbor, Mich.). J. Med. Chem.; 15: No. 9, 976-8(Sep 1972).

Methods of preparation and antiradiation activity of p-anisyl-butyl derivatives of S-2-aminoethyl hydrogen thiosulfate, 2-aminoethanethiol, the corresponding disulfide, and thiazolidine are presented. (D.H.M.)

Isotope Effects

Refer also to abstract 4231.

2364 (COO-2192-1) DEUTERIUM ISOTOPE EFFECTS IN ELECTRONIC RELAXATION OF LARGE POLYATOMIC MOLECULES. Progress Report, January 1, 1972-December 31, 1972. Lim, E. C. (Wayne State Univ., Detroit, Mich.). [nd]. Contract AT(11-1)-2192. 7p. Dep. NTIS.

Studies were made on the deuterium isotope effect in fluorescence of anthracene vapor to determine if the isotope effect on intersystem crossing depends, in some predictable manner, on the excess vibrational energy of the molecule. Results suggested the occurrence of a small (or even inverse) isotope effect in the low excess energy region and significant normal deuteration effect in the region of high excess energy may be a general phenomenon for radiationless singlet deactivation of isolated polycyclic aromatic hydrocarbons. Examination of recent emission data on four aromatic hydrocarbons indicates that the D/H ratio of the quantum yields of phosphorescence is considerably smaller than the corresponding ratio of the lifetimes, indicating that the radiative lifetime of the lowest triplet state increases on deuteration. A large deuteration effect on the radiative lifetime of the lowest triplet state is therefore expected on the basis of the non-Born-Oppenheimer coupling mechanism. (M.C.G.)

2365 RADIATIONLESS DECAY PROCESSES IN BENZENE; AN EXTERNAL DEUTERIUM ISOTOPE EFFECT. Simons, J. P.; Smith, A. L. (Univ. of Birmingham, Eng.). Chem. Phys. Lett.; 16: No. 3, 536-41(15 Oct 1972).

C_6H_6 or C_6D_6 and $CHCl_3$ form weak complexes in glassy 3-methylpentane solution at 77°K. Substitution of $CDCl_3$ for $CHCl_3$ greatly increases the phosphorescence efficiency and decay time of the benzene and suppresses the photochemical production of hexatrienes. The observations can be understood if there is vibronic coupling of the triplet benzene with the C-H motion in the $CHCl_3$, which accelerates the rate of its radiationless decay. (auth)

2366 ISOTOPE EFFECTS ON INTERMOLECULAR INTERACTIONS IN CRYSTALLINE BENZENE. Colson, S. D.; Netzel, T. L. (Yale Univ., New Haven). Chem. Phys. Lett.; 16: No. 3, 555-9(15 Oct 1972).

Spectroscopic studies of pure and isotopic mixed benzene crystals have shown that for the $S_1 \leftarrow S_0$ transition the resonance interactions in pure C_6H_6 and C_6D_6 are identical; the effects of the static (binding) forces are the same in pure C_6H_6 and C_6D_6 crystals; and the gas-to-crystal shift of a dilute guest in an isotopic mixed

crystal is different from that of the host. These results provide a consistent explanation of the differences between calculated and experimental spectra of heavily doped isotopic mixed benzene crystals. (auth)

2367 HYDROGEN ATOM ABSTRACTION BY METHYL RADICALS IN METHANOL GLASSES AT 67 TO 77°K. Campion, A.; Williams, F. (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. J. Amer. Chem. Soc.; 94: No. 22, 7633-7(1 Nov 1972).

It was shown by ESR studies that the thermal decay of $CH_3\cdot$ radicals in a methanol-d glass at 77°K proceeds with the concomitant formation of the $\cdot CH_2OD$ radical. The reaction obeys first-order kinetics over 75% of its course, and there is reasonably good agreement between the rate constants as determined from $CH_3\cdot$ decay and $\cdot CH_2OD$ growth. At 77°K, the rates of H-atom abstraction by $CH_3\cdot$ from CH_3OD and CH_3OH are comparable, but the rate of $CH_3\cdot$ decay in CD_3OD is slower by at least 1000-fold. This primary deuterium isotope effect confirms that abstraction occurs almost exclusively from the hydrogens of the methyl group. The apparent activation energy of 0.9 kcal mol^{-1} for the abstraction reaction in the glassy state at 67 to 77°K is much lower than the value of 8.2 ± 0.2 kcal mol^{-1} previously reported for essentially the same reaction in the gas phase above 376°K. These findings are remarkably similar to those reported for H-atom abstraction by $CH_3\cdot$ radicals from acetonitrile and methyl isocyanide and are consistent with the proposal that these reactions proceed mainly by quantum mechanical tunneling at low temperatures. When $CH_3\cdot$ radicals are produced by the photolysis of CH_3I and of TMPD (N,N,N′,N′-tetramethyl-p-phenylenediamine)–CH_3Cl with uv light in methanol, the contribution of hot radical processes to the abstraction reaction appears to be negligibly small in comparison with the rate of the thermal reaction. (auth)

2368 MECHANISTIC ASPECTS OF THE SILVER(I)-PROMOTED REARRANGEMENTS OF TRICYCLO[4.1.0.$0^{2,7}$]HEPTANE DERIVATIVES. DEUTERIUM ISOTOPE EFFECT STUDIES AND INDEPENDENT GENERATION OF ARGENTO CARBONIUM IONS. Paquette, L. A.; Wilson, S. E.; Henzel, R. P. (Ohio State Univ., Columbus). J. Amer. Chem. Soc.; 94: No. 22, 7771-9(1 Nov 1972).

Kinetic deuterium isotope effects were determined for the Ag^+-catalyzed rearrangements of 1,7-dideuterio-(1), 1-deuterio-7-methyl-(2), and 1-trideuteriomethyltricyclo[4.1.0.$0^{2,7}$]heptanes (3). Dideuterio analog (1) exhibited a faster rate of isomerization to 1,3-cycloheptadiene-2,3-d_2 than its protio counterpart, thereby giving rise to an inverse fractionation factor (k_H/k_D = 0.847). A similar rearrangement of (2) revealed that isomeric ethylidenecyclohexenes as well as 2-methylcycloheptadiene were also produced under the control of inverse isotope effects (k_H/k_D = 0.95 and 0.91, respectively). Most interestingly, the formation of bicyclo[3.2.0]-heptene is subject to a virtual primary deuterium isotope effect (1.74). The mechanistic implications of the isotope data are discussed, and suggested pathways are advanced to account for the genesis of the various products. (auth)

2369 ELECTROORGANIC CHEMISTRY. X. ANODIC ALLYLIC SUBSTITUTION. Shono, T.; Ikeda, A. (Kyoto Univ.). J. Amer. Chem. Soc.; 94: No. 22, 7892-8(1 Nov 1972).

Allylically substituted products were obtained in the anodic oxidation of some olefins, such as cyclohexene, cyclopentene, methylcyclohexenes, and octenes, in acetic acid or methanol. α- or β-pinene gave ringopened products and norbornene yielded transannularly interacted product, 3-substituted nortricyclene. Isotope effect for anodic acetoxylation of cyclohexene was 1.6. The current efficiency decreased with lowering of oxidation potential of supporting electrolyte. The cation radical formed from one-electron oxidation of the substrate was the initial reactive species and an allylic cation was the main intermediate in the product-determining step. (auth)

2370 KINETIC ISOTOPE EFFECTS. 7. IONIZATION OF (d)-PHENYLMETHYLACETOPHENONE. Earls, D. W.; Jones, J. R.; Rumney, T. G. (Univ. of Surrey, Guildford, Eng.). J. Chem. Soc., Faraday Trans., I; 68: No. 5, 925-31(1972).

Measurements are reported on the hydroxide-catalyzed ionization of (d)-phenylmethylacetophenone in the presence of varying amounts of dimethyl sulphoxide. The kinetic hydrogen isotope effect (k_H/k_T) increases with increasing basicity until at a H value of 16.5 it reaches a maximum. The value of the Brönsted exponent is 0.49 ± 0.02 for both isotopes. For several media, activation energies and pre-exponential factors were determined. The ratios of A_H/A_T reflect the importance of solvent reorganization contributions. (auth)

2371 FINE STRUCTURE OF $^3\Pi$ AND $^3\Sigma^-$ STATES IN DIATOMIC MOLECULES. Veseth, L. (Univ. of Oslo). J. Phys., B (London); 5: No. 2, 229-41(Feb 1972).

The fine structure of the A $^3\Pi$ and X $^3\Sigma^-$ states of ND, NH, and OH^+ was investigated. An iteration procedure based on numerical matrix diagonalization takes the $^3\Pi-{}^3\Sigma^-$ interaction completely into account, and contributions from singlet states are considered to second order. Centrifugal distortion terms are included in the off-diagonal $^3\Pi-{}^3\Sigma$ matrix elements through a quantum mechanical approach, and these terms are found to yield the correct explanation for the Λ doubling anomalies encountered for high rotational quantum numbers. The dependence of the coupling constant A on the rotational quantum number observed by previous investigators is removed, even for the highest rotational quantum numbers (J = 30), through the inclusion of higher order terms and the spin–rotation interaction. The A $^3\Pi$ state of AsD and AsH is briefly commented on, and the relation $A = A_0 + 2A_1J(J+1)$ is found to explain certain anomalies in the multiplet splitting. For the $^3\Sigma^-$ state the unified treatment of the $^3\Pi-{}^3\Sigma^-$ interaction leads to some further conclusions regarding the origin of the spin splitting. (auth)

2372 OXIDATION OF CARBON MONOXIDE MIXTURES WITH ADDED HYDROGEN OR DEUTERIUM. Marlow, John Hays. Cambridge, Mass.; Harvard Univ. (1972). 154p. University Microfilms Order No. 72-24,650.

Thesis.

The oxidation of CO by O_2 with small amounts of added deuterium or hydrogen was investigated to determine the isotope effect in very dilute mixtures with argon at about 5.5×10^{17} particles/cc total concentration. The reaction was followed in incident shock waves by measuring particle time over the 1700° to 2600°K range. The reaction shows an initial accelerating rate followed by a period of constant rate of CO_2 production. The observed [CO_2] vs. time profiles were compared to those calculated numerically on an IBM 360/65 computer. These calculations used a branching chain reaction proposed by others involving hydrogeneous impurities. In the calculations in which deuterium was substituted for hydrogen, the least square averages of literature values of k_{3H_2}, k_{5H_2}, and k_{6H_2} and the best fit of k_{1H_2}, k_{2H_2} and k_{4H_2} were used. Starting with these and to obtain the values of k_{2D_2} and k_{4D_2} for deuterium, all isotope effects were attributed to the frequency factors. The best fit to the experimental results occurred in the calculations when the following values were used: $k_{2D_2} = 1.15 \times 10^{-10}$ exp(–10,000/RT) cc molecule^{-1} sec^{-1} and $k_{4D_2} = 1.46 \times 10^{-12}$ exp(–1,030/RT) cc molecule^{-1} sec^{-1}. This resulted in an isotope effect ratio for k_2 as k_{H_2}/k_{D_2} = 1.3 and k_4 as k_{H_2}/k_{D_2} = 1.3. (TSS) (Diss. Abstr. Int., B)

2373 KINETIC ISOTOPE EFFECTS AS PROBES FOR NEIGHBORING PHENYL GROUP PARTICIPATION IN SOLVOLYSIS REACTIONS. Cramer, John Allen. Athens, Ohio; Ohio Univ. (1972). 161p. University Microfilms Order No. 72-26,364.

Thesis.

Remote para-deuterium kinetic isotope effects for the aqueous ethanolysis of 1,1,1-triphenyl-2-propyl tosylate (1), 3-methyl-3-phenyl-2-butyl brosylate (2), and 2-methyl-1-phenyl-2-propyl chloride (3) were determined employing a precise (±0.05%) conductometric method for rate constant measurement. The isotope effects for solvolysis of (1), (2), and (3) were found to be 0.977, 0.987, and 0.997, respectively. Phenyl participation, on the basis of both kinetic rate enhancement and product criteria, was demonstrated to be important in the solvolysis of 1 and 2 but of no importance in the solvolysis of 3. Based upon the large inverse para-d effects obtained for the solvolysis of 1 and 2 coupled with the negligible isotope effect obtained for the solvolysis of 3, it is concluded that the measurement of such effects constitutes a direct probe for aryl-bridged rate-determining activated complexes in the solvolysis reactions of β-arylalkyl systems. The observation of a 0.986 para-d isotope effect for the aqueous ethanolysis of threo-3-phenyl-2-butyl brosylate (4) is inconsistent with the Brown equilibrating classical ion mechanism for solvolysis of 4, since this mechanism does not involve rate-determining formation of a phenyl-bridged activated complex. The isotope effect does offer, however, compelling evidence in favor of the intervention of phenonium ions as postulated by Cram. (Diss. Abstr. Int., B)

2374 STUDIES OF ELECTRONIC FACTORS IN CATALYSIS OF HYDROGEN–DEUTERIUM EXCHANGE AND CARBON MONOXIDE OXIDATION OVER ZINC OXIDE. Veerkamp, Thomas Francis. Houston, Tex.; Rice Univ. (1972). 172p. University Microfilms Order No. 72-26,482.

Thesis.

The influence of ultraviolet and visible irradiation on the rate constants of two types of reactions over n-type semiconductor ZnO, the exchange of H_2-D_2 and the oxidation of CO, was investigated. The results of the two types were related together by a study of electrical conductivity and Seebeck effect for the catalyst. From this was formed a unified, consistent picture of electronic factors controlling catalysis over ZnO. (TSS) (Diss. Abstr. Int., B)

2375 UNIMOLECULAR REACTIONS OF POLYATOMIC MOLECULES, RADICALS, AND IONS. Setser, D. W. (Kansas State Univ., Manhattan). pp 1-43 of Chemical Kinetics. /Polanyi, J. C. (ed.). Baltimore; University Park Press (1972).

Quantitative experimental work that can be related to theoretical predictions is reviewed. Topics discussed are: fall-off results and isotope effects in thermal collisional activation, chemical activation yielding products of known energy, chemical activation yielding products with unspecified energy, and statistical theory of unimolecular reactions. Applications of nonequilibrium techniques are summarized. (254 references) (J.G.B.)

Isotope Exchange and Isotope Separation

Refer also to abstracts 2432, 2649, 2855, and 4417.

2376 ISOTOPIC EXCHANGES PRODUCED BY HIGH ENERGY MOLECULAR JETS. THEIR UTILIZATION IN MASS SPECTROMETRY. Devienne, F. M. Compt. Rend., Ser. C; 274: No. 14, 1325-7(5 Apr 1972). (In French).

Deuterated methane compounds were obtained from a deuterium–methane mixture by bombardment with neutral particle beams (e.g., He atoms at 6 keV). The partial pressure of deuterium in the mixture is twenty times greater than that of methane. The isotopic exchange increases with the ratio of the partial pressures of deuterium and methane. The mass spectrum of the mixture is presented. (France)

2377 DETRITIATION OF MALONONITRILES IN MIXED AQUEOUS SOLVENTS AND IN SALT SOLUTIONS. A KINETIC PROBE FOR SOLVENT BASICITY. Hibbert, F.; Long, F. A. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc.; 94: No. 22, 7637-41(1 Nov 1972).

The water-catalyzed detritiations of malononitrile and its tert-butyl derivative represent an interesting new probe for solvent basicity. The rates of detritiation were measured in mixed solvents of water with dioxane, ethanol, and dimethyl sulfoxide. Replacement of water by the nonaqueous component leads to a rate maximum at about 0.2 mol fraction replacement, implying an initial increase in solvent basicity. The magnitudes of the maxima (dimethyl sulfoxide > ethanol > dioxane) and the solvent compositions at which they occur vary with the particular nonaqueous additive. In largely nonaqueous solution, the rate is reduced below its value in water; i.e., the basicities decrease. The overall variation of the rate of detritiation with solvent composition in water–ethanol roughly follows the H_- indicator acidity function, but this correlation breaks down for water–dioxane solutions. In the presence of tetraalkylammonium halides the rate of the water-catalyzed detritiation of tert-butylmalononitrile is increased; the magnitude of the effect increases with the cationic radius of the salt. Alkali metal halides reduce the rate. These salt effects and the influences of mixed solvents on the rate of detritiation can be understood in terms of medium effects on the activity of the ion-pair transition state. The kinetic results also correlate closely with effects on the structure of water. (auth)

2378 ELECTROPHILIC REACTIONS AT SINGLE BONDS. VII. HYDROGEN–DEUTERIUM EXCHANGE ACCOMPANYING PROTOLYSIS (DEUTEROLYSIS) OF THE BOROHYDRIDE AND ALUMINUM HYDRIDE ANIONS WITH ANHYDROUS STRONG ACIDS. THE INTERMEDIACY OF PENTAHYDROBORON (BH_5) AND PENTAHYDROALUMINUM (AlH_5) AND THEIR STRUCTURAL RELATIONSHIP WITH THE METHONIUM ION (CH_5^+). Olah, G. A.; Westerman, P. W.; Mo, Y. K.; Klopman, G. (Case Western Reserve Univ., Cleveland). J. Amer. Chem. Soc.; 94: No. 22, 7859-62(1 Nov 1972).

Hydrogen–deuterium exchange accompanying protolysis (deuterolysis) of the borohydride (BH_4^-) and aluminum hydride (AlH_4^-) anions suggests the intermediacy of pentahydroboron (BH_5) and -aluminum (AlH_5). Pentahydroboron (BH_5) is both isoelectronic and isosteric with the methonium ion (CH_5^+). Theoretical calculations (CNDO/2 method) favor the BH_5 structure with C_s symmetry. These data suggest that the electrophilic attack on BH_4^- (AlH_4^-) is on the boron-hydrogen σ bond via the formation of a two-electron three-center bond and not through direct linear hydride ion transfer. In addition, trialkylboranes (alanes) and tetraalkylborates also undergo similar protolytic cleavage reaction with HF to give alkanes and $BF_3(AlF_3)$. (auth)

2379 ATOMIC AND BIMOLECULAR REACTIONS. Campbell, I. M.; Baulch, D. L. (Univ. of Leeds, Eng.). pp 45-73 of Chemical Kinetics. /Polanyi, J. C. (ed.). Baltimore; University Park Press (1972).

Literature published during 1969 and 1970 on the kinetics of atomic and bimolecular reactions (excepting that on excited atoms) is reviewed. Topics discussed are effects of internal energy on reactivity, reactions of carbon atoms $C(^3P)$, $C(^1D)$, and $C(^1S)$, reactions of halogen atoms ($^2P_{\frac{1}{2}}$), reactions of hydrogen atoms (^2S), reactions of nitrogen atoms $N(^4S)$, reactions of oxygen atoms $O(^3P)$, reactions of sulfur atoms $S(^3P)$ and $S(^1D)$, reactions of diatomic species, and bimolecular reactions. Deuterium–hydrogen and oxygen-16–oxygen-18 exchange reactions are considered. (162 references) (J.G.B.)

2380 MOLECULAR BEAM REACTIONS. Kinsey, J. L. (Massachusetts Inst. of Tech., Cambridge). pp 173-212 of Chemical Kinetics. /Polanyi, J. C. (ed.). Baltimore; University Park Press (1972).

Material on molecular beam reactions published since 1966 is reviewed. A previously published list of all reactions successfully studied up to that time is updated through July, 1971. The discussion is presented under the following headings: cross sections for reactive systems, experimental techniques, discussion of specific systems (with reference to the hydrogen–deuterium exchange reaction), and other relevant studies. (160 references) (J.G.B.)

2381 ION–MOLECULE REACTIONS. Dubrin, J. (Massachusetts Inst. of Tech., Cambridge); Henchman, M. J. pp 213-45 of Chemical Kinetics. /Polanyi, J. C. (ed.). Baltimore; University Park Press (1972).

The choice of topics in this review is highly subjective and the coverage of the literature selective, insofar as it has been used to illustrate particular themes. Critical review articles are referred to frequently. Energy and reactivity in the gas phase is discussed as to (1) reaction rates: excitation functions and rate constants and (2) reaction mechanisms: collision dynamics. Also discussed is the role of solvation in the liquid phase: the relationship of gas-phase studies to wet chemistry. Reference is made to studies involving deuterium and hydrogen in ion–molecule reactions. (123 references) (J.G.B.)

2382 V_{OH}^*: A NOVEL DEUTERIUM-EXCHANGEABLE HYDROGEN-CONTAINING TRAPPED HOLE CENTER AT THE SURFACE OF MgO. Derouane, Eric G. (Univ., Liege); Indovina, Valerio. Chem. Phys. Lett.; 16: No. 2, 359-64(1 Oct 1972).

A tentative analysis is proposed for the EPR spectrum of the paramagnetic surface centre V_{OH}^* observed after consecutive adsorptions of H_2 and H_2O vapor on fresh MgO powders evacuated at 1200°K. (auth)

2383 PROBLEMS OF THE MECHANISM OF THE ISOTOPIC EXCHANGE DURING THE DETERMINATION OF OXYGEN IN LANTHANUM AND LITHIUM FLUORIDES. Glavin, G. G.; Olzhataev, B. A.; Khokhrin, V. M. (State Scientific-Research and Design Inst. of Rare Metal Industry, Moscow). Zh. Anal. Khim.; 27: No. 9, 1851-3(Sep 1972). (In Russian).

The mechanism of isotopic exchange during the determination of oxygen in lanthanum and lithium fluorides is discussed. An isotopic equilibrium ^{16}O–^{18}O is attained in the melt much more rapidly than if the heterogeneous exchange through a gas phase is used. An experimentally found rate of the isotopic equilibrium attainment in fluoride melts makes it possible to conclude that in fluoride melts oxygen exists either as metastable compounds, dissociating to the atomic state, or as a solute. (auth)

Radiation Chemistry

Refer also to abstracts 2367, 2382, 2426, 2431, 2432, 2436, 2437, 2624, 3074, 3971, 4317, and 4337.

2384 (CALT-767-P-4-95) STUDIES IN CHEMICAL DYNAMICS AND RADIATION CHEMISTRY. Technical Progress Report. Kuppermann, A. (California Inst. of Tech., Pasadena. Div. of Chemistry and Chemical Engineering). 30 Jun 1972. 53p. Dep. NTIS.

Progress in studies on low energy electron scattering is reported. Differential cross sections for D_2 and H_2 were measured for elastic scattering by O_2, CO, NH_3, CH_4, and SF_6. Studies on the theory of chemical reactions and molecular collisions were continued. (auth)

2385 (CEA-N-1556) KINETIC BEHAVIOR OF NEUTRAL AND IONIC SPECIES IN THE GAS PHASE DURING THEIR FIRST COLLISIONS. Clerc, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Aug 1972. 119p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay.

Vacuum uv flash photolysis and pulse radiolysis of gases, including CO_2–He, N_2, N_2O, NH_3, and O_2–He, were used to study the kinetic and spectroscopic behavior of excited atoms, free radicals, and ions formed by the excitation or dissociation of simple molecules. The kinetic evolution of the ground state ions was studied using absorption spectrography techniques. Pulse

radiolysis was used to observe very rapidly occurring phenomena with a time resolution of the order of 1 nanosecond. Radiative lifetimes and oscillator strengths were measured for very short duration fluorescences. Most of the excited states of the following species were studied: 0^*, N_2, CO_2^+, N_2O^+, N_2^+, O_2^+, CH^0, and NH^0. (France)

2386 (LBL-666, pp 235-302) PHYSICAL, INORGANIC, AND ANALYTICAL CHEMISTRY. May 1972.
In Nuclear chemistry annual report, 1971.

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2387 (RRL-3238-413) QUARTERLY REPORT, JULY 1-SEPTEMBER 30, 1972. Fundamental Research No. 6041. (Mellon Inst. of Science, Pittsburgh, Pa. Radiation Research Labs.). 2 Oct 1972. Contract AT(11-1)-3238. 22p. Dep. NTIS.

Research progress in the field of radiation chemistry is reported. Scavenging and yield studies are discussed. Abstracts of papers published and to be published on this work are included. (M.C.G.)

2388 (RRL-3238-414) ANNUAL REPORT, OCTOBER 1, 1971-SEPTEMBER 30, 1972. (Mellon Inst. of Science, Pittsburgh, Pa. Radiation Research Labs.). 24 Oct 1972. Contract AT(11-1)-3238. 28p. Dep. NTIS.

Studies on ESR spectra of irradiated aqueous solutions are reported. Lists of journal publications and oral presentations on this work are included. (M.C.G.)

2389 VOLTAMETRIC BEHAVIOUR OF SOLUTIONS OF γ-IRRADIATED KCl. Gikas, G. X. (Univ. of Athens). Chem. Phys. Lett.; 16: No. 3, 605-7(15 Oct 1972).

The voltametric behavior of solutions of γ-irradiated alkali halides was studied. The existence of hydrated electrons was identified and the phenomenon of aquoluminescence may have been observed. (auth)

2390 ELECTRON SPIN RESONANCE STUDIES OF RADICAL TRAPPING IN THE RADIOLYSIS OF ORGANIC LIQUIDS. I. EVIDENCE FOR THE PRIMARY FORMATION OF THE METHOXY RADICAL IN METHANOL. Wargon, J. A.; Williams, F. (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. J. Amer. Chem. Soc.; 94: No. 22, 7917-18(1 Nov 1972).

The techniques of "spin trapping" (radical trapping followed by ESR identification of a more stable adduct radical) was used to study the problem of primary radicals formation in the radiolysis of deareated liquid methanol. It has been widely suggested that the facile ion-molecule reactions $CH_3OH^{\cdot+} + CH_3OH \rightarrow CH_3OH_2^+ + CH_3O^{\cdot}$ (1) and $CH_3OH^{\cdot+} + CH_3OH \rightarrow CH_3OH_2^+ + {}^{\cdot}CH_2OH$ (2) contribute to radical formation in the radiolysis of liquid methanol. Results show that methoxy radical is the most abundant primary radical produced in the radiolysis of liquid methanol. Results are entirely consistent with the formation of methoxy radicals by reaction 1 and that relative to the gas phase results reaction 2 is much less important than reaction 1. (D.H.M.)

2391 RADICAL REACTIONS AT 77°K: CONVERSION OF ISOBUTYL RADICALS. Leray, Nicole; Roncin, Jacques (Paris Univ., Orsay, France). Int. J. Radiat. Phys. Chem.; 4: No. 3, 347-52(Aug 1972). (In French).

The transformation of isobutyl radical trapped in different matrices into tert-butyl radical was studied by ESR. In matrices which are chemically inert or sufficiently rigid the reaction does not occur excluding a monomolecular mechanism. In glassy matrices the reaction occurs. Experiences with matrices containing certain alkylhalides support a bimolecular mechanism. (auth)

2392 PROCEEDINGS OF THE SYMPOSIUM ON GRAFT POLYMERIZATION ONTO CELLULOSE. 161st Meeting of the American Chemical Society, Los Angeles, California, March 31-April 2, 1971. Arthur, Jett C. Jr. (ed.). J. Polym. Sci., Part C; No. 37, 1-361(1972). (CONF-710354).

Twenty papers presented at the conference are included. Separate abstracts were prepared for 13 papers concerned with radiation polymerization. (M.C.G.)

For abstracts of individual papers see: 2393–2405.

2393 SOME PROBLEMS IN RADIATION GRAFTING TO CELLULOSE FIBERS. Sakurada, I.; Okada, T.; Kaji, K. (Japan Atomic Energy Research Inst., Neyagawa City). J. Polym. Sci., Part C; No. 37, 1-25(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

In the case of grafting by preirradiation method, the presence of air during preirradiation by gamma rays has practically no influence on the percent grafting, whereas the presence of water decreases the activity to a great extent. ESR studies of preirradiated cotton and rayon show that the active species for the grafting are not peroxides but free radicals even when the irradiation is carried out in air. The number of scissions of chemical bonds of the cellulose molecule by the irradiation is practically independent of the degree of polymerization and microstructure of the initial cellulosic fiber; the presence of air also has no effect on the degradation. In the case of styrene grafting, breaking strength of single fibers remains substantially unchanged by the grafting, but the increase of denier by the grafting results in a drop of tenacity (g/den) of the single fibers. Cellulosic fibers become hydrophobic by the grafting of styrene, but the tendency to absorb water calculated on the cellulose basis increases by the increasing percent graft. This may be the reason for the rather low wet tenacity of the styrene-grafted cellulosic fibers. (auth)

2394 ESR STUDY OF INTERACTIONS OF γ-IRRADIATED CELLULOSE I AND CELLULOSE II WITH AMMONIA, WATER, AND SODIUM HYDROXIDE SOLUTIONS. Hinojosa, O.; Nakamura, Y.; Arthur, J. C. Jr. (Dept. of Agriculture, New Orleans). J. Polym. Sci., Part C; No. 37, 27-46(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

The types of long-lived free radicals formed in predried cellulose I and cellulose II, after irradiation in a nitrogen atmosphere at 25°C by γ radiation from ^{60}Co, were resolved by selectively scavenging some of the radicals and then recording the ESR spectra generated. The effects of anhydrous ammonia (both gas and liquid), water, solutions of sodium hydroxide, and temperature of heating on the ESR spectra generated by the irradiated celluloses were recorded. Most of the free radicals formed in the irradiated celluloses are apparently trapped in the amorphous or less ordered regions of the cellulosic structure. About 70% of the radicals formed in irradiated cellulose I and about 90% of the radicals formed in irradiated cellulose II are scavenged by contacting the samples with water. The ESR spectra of the free radicals scavenged by water are almost identical for both irradiated celluloses. Contact of the irradiated celluloses with ammonia (liquid) scavenged most of the trapped free radicals. It also appears likely that the long-lived free radical sites in the highly ordered regions in both irradiated celluloses are the same. As shown by the effects of orientation of irradiated cellulosic fibers in the magnetic field on the ESR spectra recorded, differences in spectra for the irradiated celluloses are probably related to conformations of the trapped radicals, which are dependent on differences in crystal lattice types of cellulose I and II. (auth)

2395 GRAFT COPOLYMERIZATION OF ETHYL ACRYLATE WITH γ-IRRADIATED COTTON CELLULOSE I AND II. Nakamura, Y.; Hinojosa, O.; Arthur, J. C. Jr. (Dept. of Agriculture, New Orleans). J. Polym. Sci., Part C; No. 37, 47-55(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

The graft copolymerization of ethyl acrylate from methanol-water solutions with γ-irradiated cotton cellulose I and II was investigated by electron spin resonance spectroscopy and by the formation of cellulose-poly(ethyl acrylate) copolymer. The rate and extent of graft copolymerization reactions in these heterogeneous systems were dependent on conditions of storage of the irradiated celluloses prior to reaction, the composition of the methanol-water solutions, reaction time, agitation during the reaction, and cellulose crystal lattice type. Agitation of the heterogeneous system during reaction decreased both the rate and extent of copolymerization. From water the extent of copolymerization of ethyl acrylate with irradiated cellulose I was greater than with cellulose II; from methanol the extent of copolymerization with irradiated cellulose II was greater than with cellulose I. From methanol(40 vol-%)-water(60 vol-%) the maximum extent of copolymerization occurred with both irradiated celluloses; however, the extent of copolymerization was less with irradiated cellulose II than with cellulose I. The extent of copolymerization was directly related to the initial concentration of free radicals in the irradiated cellulose. However, a fraction of the radicals, about 10% of the maximum concentration in cellulose obtained at a dosage of 5.2×10^{19} eV/g, was apparently in the highly ordered regions of the cellulosic structure. These radicals were not scavenged and did not initiate copolymerization reactions. (auth)

2396 ROLE OF ADDITIVES IN THE RADIATION INDUCED COPOLYMERIZATION OF MONOMERS TO CELLULOSE. Dilli, S.; Garnett, J. L.; Martin, E. C.; Phuoc, D. H. (Univ. of New South Wales, Kensington, Australia). J. Polym. Sci., Part C; No. 37, 57-118(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

The radioinduced grafting of monomers to cellulose using a variety of solvents by the mutual irradiation technique is discussed. The monomers studied were styrene, 15 substituted styrenes, methylmethacrylate, vinyl acetate, and the vinylpyridines. The types of substituents examined included o-, m-, and p-halogen derivatives, also the alkylstyrenes and certain methoxy monomers. The effect of wetting and nonwetting solvents in the grafting reaction was also investigated. A Trommsdorff effect (accelerated grafting) was observed in certain systems at low doses and dose rates. The effect of oxygen, nitrogen, and vacuum on the Trommsdorff peak is discussed. The role of additives in the grafting of styrene is considered. The additives examined include aromatic and nonaromatic compounds, also typical free radical scavengers such as hydroquinone and thiourea. With certain additives sensitization is observed. A model for the grafting mechanism is proposed involving charge transfer bonded species. The role of energy transfer and free radical processes in the copolymerization reaction is also discussed. (auth)

2397 INORGANIC REDOX SYSTEMS IN GRAFT POLYMERIZATION ONTO CELLULOSIC MATERIALS. Bains, M. S. (Southern Univ., New Orleans). J. Polym. Sci., Part C; No. 37, 125-51(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

A review is attempted of inorganic redox systems in the context of free radical graft polymerization. Metal ion–H_2O_2 redox systems are considered as part of the spectrum of such inorganic and organic reagents used for the purpose. It is emphasized that the chemistry of these latter systems in particular is much like the radiation chemistry of aqueous solutions caused by high energy ionizing radiations. On the other hand, these systems involve low energy and therefore are less damaging to the substrate and relatively more specific. The reactivity of free radicals in these systems varies subtly with the system and the medium. Only the ceric ion method and [Fe(II); Fe(III)]–H_2O_2 system are most successful in grafting on cellulosic materials. Attention is paid to the features that makes these systems so useful. Concrete results from ESR study are presented, which underline the nonspecific nature of various free radical producing systems including radiations. (auth)

2398 PROPOSED NEW MECHANISM FOR CATALYZED AND UNCATALYZED GRAFT POLYMERIZATION ONTO CELLULOSE. Gaylord, N. (Gaylord Research Inst. Inc., Newark, N. J.). J. Polym. Sci., Part C; No. 37, 153-72(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

Graft copolymerization of polar vinyl monomers on cellulose in the presence of oxidizing agents, ceric ion, and radiation was presumed to be solely the result of propagation from radical sites generated on the cellulose. The uncatalyzed polymerization and graft copolymerization of methyl methacrylate in the presence of cellulose and water was presumed to involve the formation of a cellulose-water-monomer complex with the resultant generation of a covalently bonded monomer radical, which then propagates in the usual manner. The formation of grafted alternating copolymer from the radioinduced polymerization of styrene-acrylonitrile and butadiene-acrylonitrile, the radical catalyzed polymerization of styrene-methyl methacrylate and styrene-acrylonitrile-$ZnCl_2$ well as the uncatalyzed polymerization of butadiene-methyl methacrylate in the presence of cellulose and water indicates the participation of comonomer charge transfer complexes in the graft copolymerization. It is proposed that cellulose acts as a complexing agent for the activation of acceptor monomers and as a matrix for the alignment of acceptor monomer complexes ($A^{\pm}$-A-cellulose-water) and donor-acceptor comonomer complexes ($D^{\pm}$-A-cellulose water). Polymerization of the complexes is initiated spontaneously or by radicals generated on the cellulose although the latter do not become incorporated into the polymer chain. Graft copolymerization results from termination of the

growing polymer chains on cellulose by insertion into aldehyde groups. (auth)

2399 GRAFT COPOLYMERIZATION TO CELLULOSE BY MUTUAL IRRADIATION. Guthrie, J. T.; Huglin, M. B.; Phillips, G. O. (Univ. of Salford, Eng.). J. Polym. Sci., Part C; No. 37, 205-19(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

The mutual irradiation technique in vacuo was used to study the grafting (G) of styrene to regenerated cellulose film in a dioxane–water medium and the simultaneous homopolymerization (H). The initial rates R_G and R_H were directly proportional to the concentration of styrene, but the ratio of the rate constants k_p^2/k_t was ca 10^5 times greater in grafting than in homopolymerization (58 cf 3.3×10^{-4} l mole^{-1} sec^{-1}). Bimolecular termination was indicated in both cases by the observed dependences of R_G and R_H on (intensity)$^{0.5}$. The degrees of grafting utilized to determine R_H were shown to be apparent values only, since extraction of ungrafted cellulose yielded products in which the true degrees of grafting were all some ten times greater. From ESR spectra of cellulose irradiated in air a value of 1.6 was derived for G (radical) and there was some evidence of scission. Corresponding spectra of cellulose irradiated in vacuo gave G (radical) = 2.9, but no evidence of scission. The radical, formed by hydrogen abstraction, was shown to be located at the C atom. However, evidence for scission in cellulose irradiated (in the presence of dioxane–water) in vacuo and in air was provided by measurements of intrinsic viscosity, values of 13.5 and 24.6, respectively being derived for G (scission). (auth)

2400 CHEMICAL STRUCTURE OF CELLULOSE–STYRENE GRAFT COPOLYMERS. Sakurada, I.; Ikada, Y.; Nishizaki, Y. (Kyoto Univ.). J. Polym. Sci., Part C; No. 37, 265-75(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

At first polyvinyl alcohol was used as a model for cellulose, and the grafting of styrene and methyl methacrylate was carried out in a heterogeneous system by use of mutual irradiation, preirradiation, and catalytic methods. In all cases trichloroethylene or carbon tetrachloride was added to the reactor mixture to shorten the branches. True graft copolymers were isolated by vigorous alternate extraction of unreacted PVAL and homo-PST (or -PMMA), and hydroxyl groups in the copolymers were completely acetylated to carry out osmotic measurements. Molecular weights of the separated chains and the mother polymers were also determined by osmometry. The graft copolymer has only one mother PVAL molecule and one graft branch regardless of the grafting methods employed. In the case of cellulose, high tenacity rayon was used as a substrate. The reaction product was acetylated, and the extraction of homo-PST and unreacted cellulose (in the form of triacetate) was carried out with benzene (at 80°C) and CH_2Cl_2–MeOH (1:1, at room temperature), respectively. In this case also, it was shown that the graft copolymer molecule consisted of one graft branch and one mother cellulose molecule. (auth)

2401 STRUCTURAL CHARACTERIZATION OF GRAFTED COTTON FIBERS BY MICROSCOPY. Goynes, W. R.; Harris, J. A. (Dept. of Agriculture, New Orleans). J. Polym. Sci., Part C; No. 37, 277-89(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

The structure of cotton fibers grafted by radioinduced polymerization with butyl methacrylate and acrylonitrile was investigated by light and electron microscopy. Degree and uniformity of dye uptake was used to indicate uniformity of reaction. The internal structure of the fibers was studied with the transmission electron microscope using ultrathin cross sections and solubility tests. Changes in the fiber surface and types of damage caused by abrasion were evaluated with the scanning electron microscope. These tests indicated that the grafting procedure had changed the surface as well as the internal fibrillar character of the fibers and the extent of such changes increased with increasing content of graft polymer. (auth)

2402 CHROMATOGRAPHIC AND ION EXCHANGE PROPERTIES OF RADIATION COPOLYMERIZED CELLULOSES. Dilli, S.; Garnett, J. L.; Martin, E. C. (Univ. of New South Wales, Kensington, Australia). J. Polym. Sci., Part C; No. 37, 291-307 (1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

The potential of radiation copolymerized celluloses in chromatography, particularly in the reversed-phase technique, is discussed. A range of styrenated celluloses was prepared from copolymerizing styrene with Whatman 40, 41, and 42 papers. The effect of percent styrene on the separation characteristics of a number of dyestuffs on these grafted papers was studied. Significant differences in chromatographic behavior of the dyes were observed between the grafted and nongrafted papers. Similar changes in R_F values between the two types of papers were also observed for the separation of a range of 19 typical cations. Detailed studies were performed particularly with Zn^{2+}, Ni^{2+}, and Cd^{2+}. In the separation of the fatty acids, stearic, myristic, and lauric, the grafted celluloses possess advantages over the untreated Whatman equivalent. For column chromatography, a methyl methacrylate-cellulose radiation copolymer was used to quantitatively separate a mixture of oil soluble dyes. This same mixture could not be separated on a column of untreated cellulose powder. The ion exchange properties of grafted copolymers where the monomer contains a functional group such as $-NH_2$, $-SO_3H$, or even a heterocyclic nitrogen (the vinyl pyridines) are discussed. (auth)

2403 EFFECT OF VINYL MONOMER GRAFTING ON THE WATER SORPTION KINETICS AND EQUILIBRIA IN CELLULOSE. LePoutre, P. F.; Hopfenberg, H. B.; Stannett, V. (North Carolina State Univ., Raleigh). J. Polym. Sci., Part C; No. 37, 309-24(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

Wood pulp cellulose was grafted with styrene and a number of other vinyl monomers using the mutual radiation technique. The effects of the level of grafting, type of monomer, and the grafting conditions on the water sorption equilibria and kinetics were determined. Styrene was studied in considerable detail. Styrene grafting reduced the equilibrium water content but water diffusivities increased as a consequence of styrene grafting. Conversely, the grafting of polar monomers such as acrylonitrile, ethyl acrylate, and acrylic acid led to somewhat higher water regains but to decreased diffusion constants. The swelling conditions used during the mutual grafting process with styrene significantly affected the grafting rates and the properties of the resulting grafts. For example, the equilibrium water contents at the same level of grafting was a function not only of percent graft but also of the specific swelling conditions. These moisture regains were inversely related to the density of the grafted fibers. These results are discussed in terms of the conformation of the grafted side chains, which is determined by the various grafting conditions. (auth)

2404 INDUSTRIAL APPLICATION OF RADIATION INDUCED GRAFTED COTTON. Dasgupta, S. (Atomic Energy of Canada Ltd., Ottawa). J. Polym. Sci., Part C; No. 37, 333-48 (1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

Simultaneous irradiation techniques were employed for grafting vinyl monomers such as styrene, acrylonitrile, or mixtures to rolls of cotton. Reaction mechanisms and kinetics, structure of grafted cotton, and uses are discussed. The uses evaluated include: permanent press, crease, or pleat resistance enhancement; increased dimensional stability, soil, and stain release; waterproofing of fabrics; increased rot and biological degradation resistance; strength to weight ratio and abrasion resistance increases; and improved dye acceptability. Economics of the grafting process are considered. (M.C.G.)

2405 TEXTILE PROPERTIES OF COTTON CELLULOSE GRAFT COPOLYMERS AND TERPOLYMERS. Mares, T.; Arthur, J. C. Jr. (Dept. of Agriculture, New Orleans). J. Polym. Sci., Part C; No. 37, 349-57(1972).

From Symposium on graft polymerization onto cellulose; Los Angeles, CA. (31 Mar 1971). See CONF-710354.

Cotton cellulose graft copolymers and terpolymers were prepared by radiation-initiated processes. Monomers copolymerized with irradiated cellulose from solutions of methanol–water were: methacrylic acid (MAA), methacrylonitrile (MAN), and hexafluoroisopropyl acrylate (6FIPA). Cotton cellulose, immersed in solutions of N-vinyl carbazole (NVC) in 1,2-dichloroethane, was irradiated to form a copolymer. Terpolymers prepared were: cellulose–poly(MAA)–poly(MAN), cellulose–poly(MAA)–poly (6FIPA), and cellulose–poly(MAN)–poly(6FIPA). Textile properties of the cotton fabric copolymers and terpolymers determined include: flex and flat abrasion resistance, breaking strength, and water repellency. The properties of the cellulose copolymers and terpolymers were related to chemical structures of the monomers used and the glass transition temperatures of their homopolymers. (auth)

2406 IRRADIATION OF CYTOCHROME C: A DUAL WAVELENGTH SPECTROPHOTOMETRIC ANALYSIS. Wynveen, Robert Allen. New Brunswick, N. J.; Rutgers–The State Univ. (1972). 212p. University Microfilms Order No. 72-27,614.

Thesis.

Experiments have been performed to determine the susceptibility of cytochrome c to immediate and transient oxidation or reduction during exposure to 50 kVp x rays. Measurements were made on commercially available horse-heart cytochrome c in dilute aqueous solutions, containing various buffers and added phospholipids, under a variety of pH conditions. Measurements also were made on cytochrome c in mitochondrial preparations isolated from beef heart and yeast cell suspensions. A specially-designed analyzing apparatus, which included the coupling of a dual wavelength spectrophotometer with an X ray generator, is fully described. Commercially available cytochrome c, which contains approximately 90% ferricytochrome c and 10% ferrocytochrome c, undergoes an immediate net radiation-induced reduction in the presence of oxygen at dose rates ranging from 2 rads/sec to 200 rads/sec. Significant reduction of ferricytochrome c was noted for doses as low as 50 rads. Continued extended irradiation of the cytochrome c solution, however, resulted in a net reoxidation of the ferrocytochrome c. Reoxidation was also noted in certain solutions after the x ray beam was terminated. Radiation-induced destruction of the cytochrome c molecule was observed. (TSS) (Diss. Abstr. Int., B)

2407 ELECTRICAL CONDUCTIVITY TECHNIQUES FOR STUDYING THE KINETICS OF RADIATION-INDUCED CHEMICAL REACTIONS IN AQUEOUS SOLUTIONS. Schmidt, K. H. (Argonne National Lab., Ill.). Int. J. Radiat. Phys. Chem.; 4: No. 4, 439-68(Oct 1972).

A review is presented of the work of the author and his coworkers in the field of conductivity measurements on pulse-irradiated aqueous solutions. The first part deals with the development of various techniques. After a discussion of the general principles of transient conductivity measurements and some sources of error, descriptions are given of (1) a rotating-sector apparatus used with an x-ray machine, (2) an arrangement for measurements at a 15-MeV linac and its adaptation to a 2.3-MeV Febetron accelerator, and (3) a photoflash-conductivity apparatus. In the second part, applications of these techniques to the study of some radiation-chemical problems are reviewed. The problems dealt with are: (1) the diffusion coefficient of the hydrated electron, (2) formation and decay of H^+ and OH^- and (3) formation and decay of O_2^-. Some previously unpublished results are reported. (auth)

2408 SOME CONDUCTIVITY EXPERIMENTS IN PULSE RADIOLYSIS. Asmus, K.-D. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Int. J. Radiat. Phys. Chem.; 4: No. 4, 417-37(Oct 1972).

A survey is given on kinetic and mechanistic studies using a pulse radiolysis conductivity technique. Typical examples of the reactions of organic and inorganic compounds with radiation-chemically produced reducing and oxidizing species in aqueous and other polar solutions are discussed. Essential features of the experimental method are also described. (auth)

2409 E.S.R. STUDY OF PHENYLCARBOXYLIC ACIDS IRRADIATED AT LOW TEMPERATURES. Eroe-Gecs, M. (Central Research Inst. of Physics, Budapest). Int. J. Radiat. Phys. Chem.; 4: No. 4, 495-8(Oct 1972).

The radiation damage mechanism of 2-phenylpropionic and phenylacetic acid is discussed in comparison with ESR results for succinic and malonic acid. (auth)

2410 ONSAGER'S RECOMBINATION THEORY APPLIED TO LIQUID ALKANES. Terlecki, J. (Medical Academy, Danzig); Fiutak, J. Int. J. Radiat. Phys. Chem.; 4: No. 4, 469-78(Oct 1972).

A theoretical analysis of Onsager's function is presented, which determines the probability that a pair of ions will escape initial recombination. In contradistinction to the calculations of Freeman (J. Chem Phys. 39, 1580, (1963)), the isotropic distribution of the pair of ions is taken into account. The resulting expression for the probability was verified experimentally by electric conductivity measurements in irradiated n-hexane under high electric fields. The experimental results indicate that in the case of nondegassed n-hexane ionized by low-energy x rays, the effective initial separation between the ions, at room temperature, equals approximately 1.2×10^{-6} cm. A detailed discussion is included of the methods by means of which the mean ionization energy of liquid alkanes was determined. (auth)

2411 STUDIES OF TRANSIENT CONDUCTIVITY INDUCED IN IRRADIATED AQUEOUS SOLUTIONS USING A HIGH VOLTAGE PULSE. Hutton, A. M. (Inst. of Cancer Research, Sutton, Eng.). Int. J. Radiat. Phys. Chem.; 4: No. 4, 479-93(Oct 1972).

An apparatus is described for studying the effect of high field strengths on the transient conductivity induced in water by electron irradiation. A study of the effects of space charge and diffusion on the validity of the method is presented. The results indicate that field strengths up to 2.55×10^6 V/m do not interfere with initial or preferential recombination to any observable degree. An approximate theory of the effect of high fields on irradiated water is presented, leading to the conclusion that an effect may be observable above 3×10^6 V/m in accordance with the experimental result. (auth)

2412 REACTIVITY AND ELECTRONIC STRUCTURE OF EXCITED TRIFLUOROMETHYL RADICALS FORMED DURING RADIOLYSIS. Sutcliffe, H. (Univ. of Salford, Eng.). Int. J. Radiat. Phys. Chem.; 4: No. 4, 499-501(Oct 1972).

The possible electronic state of excited $\cdot CF_3$ radicals is discussed, and an attempt is made to correlate this with observed chemical behavior. (auth)

2413 LUMINESCENCE STUDY OF γ-IRRADIATED 2-METHYLTETRAHYDROFURAN GLASS. Ichikawa, Tsuneki; Yoshida, Hiroshi; Hayashi, Koichiro (Hokkaido Univ., Sapporo). J. Nucl. Sci. Technol. (Tokyo); 9: No. 9, 538-43(Sep 1972).

Thermo- and photoluminescence were studied on neat 2-methyltetrahydrofuran glass after γ irradiation at 77°K in dark. When the glass was warmed, thermoluminescence was observed at about 97°K. Photoluminescence was also induced by light of $\lambda > 600$ nm. The luminescence spectrum was structureless with a maximum at 460 nm, which coincides with the luminescence induced by stimulating free radicals with ultraviolet light (270 to 350 nm). Both the thermo- and photoluminescence are interpreted as due to the formation of an excited free radical by a charge recombination reaction. Lifetime measurements indicate that the free radical is probably excited to its fluorescent state. (auth)

2414 ELECTRICAL CONDUCTIVITY AS A SOURCE OF INFORMATION ON CHARGE CARRIERS IN LOW MOLECULAR WEIGHT ORGANIC SOLIDS. Willard, J. E. (Univ. of Wisconsin, Madison). Int. J. Radiat. Phys. Chem.; 4: No. 4, 405-15(Oct 1972).

By determination of the temperature thresholds for current flow in hydrocarbon glasses γ-irradiated at 77°K in an electrical conductivity cell, different populations of trapped charge carriers were distinguished and information was obtained on their orientation and migration under the influence of the applied field. Characterization was assisted by the use of charge scavengers, photobleaching, and blocking electrodes. The recent data suggest that the warmup conductivity current peak at 85°K from γ-irradiated 3-methylpentane, previously assigned to electron movement, results from the migration of $C_6H_{13}^-$ carbanions and monomeric cations, while that at 102°K is due to carbanions and dimeric cations. 3-Ethylpentane and methylcyclohexane give qualitatively similar curves. In all cases the fraction of the total trapped charge which reaches the electrodes is small. The warmup conductivity curves of unirradiated hydrocarbon glasses and of methyltetrahydrofuran show current peaks attributable to orientation of their molecular dipoles. These can be avoided if the electrical field is applied before cooling. (auth)

2415 REACTIONS OF SOLVATED ELECTRONS. Dainton, F. S. (Oxford Univ.). pp 271-97 of Chemical Kinetics. /Polanyi, J. C. (ed.). Baltimore; University Park Press (1972).

The following topics are discussed in this review article: basic concepts: free and localized electrons; the formation of e_s^- and e_t^-, including information on formation by spontaneous reactions, by injection into the medium, photochemically, and radiolytically; relevant physical properties of e_s^- and e_t^-; evidence for a broad distribution of cavity sizes and energies; rate processes not involving chemical reaction: solvation, relaxation, and mobilization; and, chemical reactions of the solvated electron. (59 references) (J.G.B.)

2416 ELECTRON AFFINITY OF WATER AND THE STRUCTURE OF THE HYDRATED ELECTRON. Ballard, R. E. (Univ. of East Anglia, Norwich, Eng.). Chem. Phys. Lett.; 16: No. 2, 300-1 (1 Oct 1972).

The electron affinity of water was obtained by a new method and a value of 1.3 eV is proposed. This value is consistent with an ice-like structure for the hydrated electron in which four water molecules are disposed about a central water anion, there being small (≈10°) changes from the ice structure values of the angles between the dipole moments. (auth)

2417 PICOSECOND PULSE RADIOLYSIS OF CYCLOHEXANE SOLUTIONS. Beck, G.; Thomas, J. K. (Univ. of Notre Dame, Ind.). Chem. Phys. Lett.; 16: No. 2, 318-19(1 Oct 1972).

A rapid ($t < 500$ psec) transfer of singlet energy was observed in the picosecond pulse radiolysis of dilute (10^{-3}–10^{-2} M) solutions of aromatic solutes in cyclohexane. This event is not associated with any ion neutralization reaction, but is a direct transfer of energy from an excited state of cyclohexane ($t_e < 500$ psec) to the solute. (auth)

2418 SPECTROPHOTOMETRIC INVESTIGATION OF SHORT-LIVED PRODUCTS OF PHOTOREACTIONS OF URA-

NIUM(VI). Pygalov, L. N.; Chibisov, A. K.; Karyakin, A. V.; (and others) (Inst. of Geochemistry and Analytical Chemistry, Moscow). Teor. Eksp. Khim.; 8: No. 4, 484-9(1972). (In Russian).

Short-lived intermediate products of uranium(VI) produced in pure solutions and in the presence of electron donors and acceptors were investigated by pulsed photolysis methods. The absorption spectra of such intermediates and the kinetics of their conversion were measured. The time of disappearance of absorption bands at $\lambda = 590$ nm coincided with the extinction of protracted fluorescence. The extinction constant of (UO_2^{3+}) was determined for various electron donors, and the disintegration rates of intermediate products and the extinction coefficient of U(V) were measured. (tr-auth)

2419 STRUCTURE OF FREE RADICALS IN AN IRRADIATED SINGLE CRYSTAL OF D,L-α-AMINOBUTYRIC ACID HYDROCHLORIDE. Tsvetkov, Yu. D.; Almanov, G. A. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Teor. Eksp. Khim.; 8: No. 4, 566-9(1972). (In Russian).

The EPR spectrum of an irradiated single crystal of DL-α-aminobutyric acid hydrochloride (ABAH) was determined. The single crystals of ABAH were cooled to 77°K and then were exposed to 10 MR of gamma radiation from a ^{60}Co source. Radicals of the type $CH_3-CH_2-\dot{C}H-COO^-$ were formed which were stable at room temperature. Isotropic and anisotropic constants of interaction for this radical and the orientation of the methylene group were evaluated. A secondary paramagnetic group which was formed upon the irradiation of ABAH was apparently a radical of the type $CH_3-\dot{C}H-CH(NH_3^+)COO^-$. (K.S.W.)

2420 EFFECT OF IONIZING RADIATION ON POLYSTYRENE AND CELLULOSE DIACETATE WITH ADDITIONS OF DYE. Kovalenko, L. M.; Lavrentovich, Ya. I.; Kabakchi, A. M. (Inst. of Physical Chemistry, Kiev). Ukr. Khim. Zh.; 38: No. 7, 646-8(Jul 1972). (In Russian).

The effects of ^{60}Co γ radiation, deuterons, and α particles on polystyrene and cellulose diacetate which contained 1,4-diaminoanthraquinone (DAAQ) were studied. It was found that DAAQ discolors in polymers linearly with the magnitude of the dose in the range from 1 to 10 MR for cellulose diacetate, and from 5 to 90 MR for polystyrene. The radiation yield of conversion of DAAQ in cellulose diacetate remained practically constant, but in polystyrene decreased with increase of the linear loss of energy. The data indicated absorbed energy in the polymers in the early stages of radiolysis. (tr-auth)

2421 RADIATION POLYMERIZATION OF AMINOPROPARGYL ESTERS OF METHACRYLIC ACID. Usmanov, Kh. U.; Musaev, U. N.; Azimov, A. A.; (and others) (Tadzhik State Univ., Stalinabad, USSR). Izv. Vyssh. Ucheb. Zaved., Khim. Khim. Tekhnol.; 15: No. 8, 1217-21(1972). (In Russian).

The kinetics of radiation polymerization of 4-(N-piperidyl-2-butynyl) methacrylate and 4-(N-2-methylpiperidyl-2-butynyl) methacrylate were studied, by distilling the monomers in a vacuum and exposing them in glass ampules to γ radiation (source not specified). Under these conditions the polymerization rate was proportional to the 0.6 power of the dose rate. The nature of the solvent used and the monomer concentration both affected the polymerization rate. (K.S.W.)

2422 γ-RADIOLYSIS OF LIQUID AMMONIA. Sakumoto, Akihisa (Japan Atomic Energy Research Inst., Tokai). Nippon Kagaku Kaishi; No. 9, 1591-6(Sep 1972). (In Japanese).

The effect of temperature, dose rate, and various additives such as acetone, nitrate ion, nitrous oxide, and water were studied in the γ radiolysis of liquid ammonia. Up to doses of about 10^{19} eV/g almost dose-independent G values of 0.12 for N_2H_4, 0.82 for H_2, and 0.21 for N_2 were obtained at 30°C. The N_2H_4 concentration at the steady state was 5.6×10^{-7} mole/NH_3 mole for doses greater than 8×10^{19} eV/g, where G values of H_2 and N_2 increased to 0.84 and 0.27, respectively. The stationary N_2H_4 concentration showed a significant increase upon lowering the irradiation temperature in the case of the liquid phase. In the solid phase, at –196°C, G values were 0.08, 0.2, and 0.04 for N_2H_4, H_2, and N_2, respectively. The rate of formation of N_2H_4 depended on the dose rate at relatively high dose. The presence of nitrous oxide, a typical electron scavenger in aqueous solutions, led to a decrease in the N_2H_4 yield. On the other hand, a maximum yield of N_2H_4 was obtained at the concentration of about 50 mole % NH_3 in an aqueous solution at an irradiation temperature of 30°C. (auth)

2423 POLYMERIZATION OF VINYL ACETATE WITH IRRADIATED LOW MOLECULAR WEIGHT ORGANIC SOLIDS. Yoshitake, Toshihiko (Kuraray Co., Ltd., Kurashiki, Japan). Nippon Kagaku Kaishi; No. 9, 1735-40(Sep 1972). (In Japanese).

The polymerization of vinyl acetate with trapped radicals in various organic solids, especially lauric acid, irradiated with ^{60}Co γ rays, was investigated. It was observed that vinyl acetate is polymerized with various irradiated organic solids, but the degree of polymerization is low. The recombination of radicals, formed by the dissolution of irradiated organic solids in monomer solutions, is considered as one of the causes of this low yield. In the polymerization of vinyl acetate with preirradiated lauric acid at 20°C, the yield of poly(vinyl acetate) was maximum when the methanol content in the monomer solution used to control the solubility of lauric acid was 7.7% and when the preirradiation dose on lauric acid was 2 to 4 MR. The effect of polymerization temperature on the yield of poly(vinyl acetate) was studied. At low temperature, the polymerization of vinyl acetate appeared to be induced mainly by trapped radicals but in the case of polymerization at 60°C, it seemed to be initiated by decomposition of peroxide produced with irradiation. (auth)

2424 SOLID-STATE RADICAL REACTIONS IN γ-IRRADIATED TERT-BUTYLCYCLOHEXANE. Acker, S.; Leray, N.; Roncin, J. (Paris Univ., Orsay, France). Int. J. Radiat. Phys. Chem.; 4: No. 4, 502-4(Oct 1972). (In French).

Radicals formed by irradiation in an organic matrix may undergo different modifications (isomerization, or bimolecular reactions with molecules of the matrix). It is shown that in the case of the radicals formed in tert-butyl cyclohexane the reaction observed is bimolecular. (auth)

2425 RADIATION-CHEMICAL GRAFTING OF ORGANOPHOSPHORUS MONOMERS ONTO POLYETHYLENE. Popova, A. I.; Serenkov, V. I.; Gefter, E. L. Plast. Massy; No. 11, 40-2 (1971). (In Russian).

The radioinduced grafting of the bis(β-chloroethyl) ester of vinylphosphonic acid (vinyphos) onto polyethylene was studied. Various aspects of the grafting process and properties of the graft copolymers were also studied. Unstabilized polyethylene film was used for grafting. Specimens underwent gamma irradiation from a Co-60 source. The effect of the solvent (in air) on the degree of grafting (the highest degree of grafting was found with the use of acetone) was studied. Effects of solution concentration, dose rate, and film thickness on yields of graft copolymer during irradiation of films immersed in an acetone solution of vinyphos, and the effects of degree of grafting on the physicomechanical indices of film (35 microns thick) from polyethylene–vinyphos copolymer were also studied. It was found that the quantity of graft copolymer is proportional to the concentration of vinyphos in acetone to 50 vol percent, while a further increase in concentration does not affect the yield of graft copolymer. The yield of graft copolymer does not exceed 45 to 46 percent with an irradiation dose of 40 Mrad for films 35 microns thick. The degree of grafting declines slightly with a film thickness of 70 microns and drops sharply with a thickness of 200 microns. The grafting process is evidently determined by diffusion of the monomer into the polymer. The quantity of graft vinyphos can be increased by the method of successive irradiation. (JPRS)

Radiochemistry and Nuclear Chemistry

Refer also to abstracts 3971 and 4366.

2426 (NP–19584) SOURCE MATERIAL FOR RADIOCHEMISTRY. 1970 Revision. Nuclear Science Series Report Number 42. (National Academy of Sciences–National Research Council, Washington, D. C. Committee on Nuclear Science). 1971. 117p. National Academy of Sciences, Washington, D. C. $2.75.

References are presented to books, reviews, and journal articles covering basic nuclear physics and chemistry, radiochemical separations and counting techniques, compilations of useful data, information on obtaining radioactive isotopes, the design of radiochemical laboratories, radiological safety, and applications to some major fields of concern to the chemist. Generally only readily available literature in the English language is included. (M.C.G.)

Hot-Atom Chemistry

Refer also to abstracts 2375, 2384, and 2386.

2427 (COO–1713–26) PRIMARY REACTIONS OF RECOILING GERMANIUM ATOMS. Gaspar, P. P.; Frost, J. J. (Washington Univ., St. Louis, Mo. Dept. of Chemistry). [nd]. 7p. (CONF-710927–2). Dep. NTIS.

From sixth international hot atom chemistry symposium; Upton, N. Y. (7 Sep 1971).

Data on reactions of germanium atoms are presented and a mechanistic scheme proposed for these reactions similar to that proposed for recoiling silicon atom reactions. The systems studied were pure germane and germane–silane mixtures. ^{75}Ge is the principal recoil product. Insertion reactions are proposed as the sole bond-forming steps included. The recoiling germanium atoms give vibrationally excited divalent intermediates. These excited intermediates can undergo collisional deactivation, unimolecular dissociation, or a second insertion. (M.C.G.)

2428 (ORO–3602-13) REACTIONS OF CHARGED AND NEUTRAL RECOIL PARTICLES FOLLOWING NUCLEAR TRANSFORMATIONS. Progress Report No. 6. Ache, H. J. (Virginia Polytechnic Inst. and State Univ., Blacksburg (USA). Dept. of Chemistry). Sep 1972. Contract AT(40-1)-3602. 31p. Dep. NTIS.

Research progress is reported on: reactions of energetic particles generated in nuclear reactions, crystallochemical reactivity of trapped recoil particles, radiation effects that accompany hot atom reactions, applications of the positron annihilation process as nuclear microprobe, and radioactive labeling of organic compounds by nonsynthetic methods. Lists of publications are given. (M.C.G.)

2429 (UCI–34-P-126-X-4) RADIOCHEMISTRY RESEARCH. Progress Report. Rowland, F. S. (California Univ., Irvine. Dept. of Chemistry). 1972. Contract AT(04-3)-34. 16p. Dep. NTIS.

Scientific progress has been quite satisfactory during the past contract year with excellent progress in the recoil chemistry of tritium, ^{18}F, and ^{38}Cl and in photochemical hot atom research. Abstracts of work published, or in the process of being published, since the submission of our previous proposal are given. The research on "molecular" neutron activation analysis was successful on prototype systems and results are ready for publication. (auth)

2430 CHEMICAL EFFECTS OF THE (n,γ) REACTION IN COBALTAMMINE COMPLEX SALTS. Ambe, Shizuko (Inst. of Physical and Chemical Research, Saitama, Japan); Tominaga, Takeshi; Saito, Nobufusa. Radioisotopes (Tokyo); 21: No. 9, 543-8(Sep 1972). (In Japanese).

The chemical behavior of recoil ^{60}Co in neutron-irradiated cobalt compounds was investigated with a series of cobaltammine salts: $[Co(NH_3)_6](NO_2)_3$, $[Co(NH_3)_5NO_2](NO_2)_2$, cis- and trans-$[Co(NH_3)_4(NO_2)_2]Cl$. The distribution of ^{60}Co among various species in the irradiated salt solutions was dependent upon both the irradiation conditions and the storage conditions after the irradiation. Eighty to ninety percent of ^{60}Co was found with the Co(II) fraction when the samples were subjected to chemical separation immediately after irradiation at dry ice temperature. The percentage distribution of ^{60}Co in the fractions other than Co(II) and target species fractions was negligibly small. The irradiation of the samples at ambient reactor temperatures brought about a decrease in the percentage distribution of ^{60}Co in the Co(II) fractions. The decrease in the activity of ^{60}Co in the Co(II) fraction was accompanied by an increase of ^{60}Co in the fractions of neutral, anionic, cis- and trans-tetraammine-, pentaammine- and hexaamminecobalt species. (auth)

2431 (n,γ) REACTIONS OF IODINE IN AQUEOUS METHYL IODIDE SOLUTIONS. Mohan, H.; Iyer, R. M. (Bhabha Atomic Research Centre, Bombay). Radiat. Eff.; 15: No. 3-4, 227-30 (Aug 1972).

The (n,γ) reactions of iodine in aqueous methyl iodide solutions in the presence and absence of O_2, I_2, and H_2O_2 give different organic yields. On the basis of the results a mechanism leading to the organic fixation of the radioactive iodine was suggested. The results indicate that the organic yield of 30% observed in oxygen saturated systems is made up of 6.5% due to geminate reactions, 13% arising out of reactions of electrons and 10.5% arising out of nongeminate reactions of H atoms and CH_3 radicals. (auth)

2432 CHEMICAL KINETICS. Polanyi, J. C. (ed.). MTP International Review of Physical Chemistry, Series One, Volume 9. Baltimore; University Park Press (1972). 330p. $24.50.

Progress in research on chemical kinetics is reviewed. There are ten chapters, seven of which have been abstracted separately for NSA. The remaining chapters deal with discussions of chemiluminescent reactions, energy-transfer processes, and relaxation techniques. (J.G.B.)

For abstracts of individual chapters see: 2375, 2379–2381, 2415, 2433, and 2434.

2433 REACTIONS OF FREE RADICALS. Whittle, E. (University Coll., Cardiff, Wales). pp 75-108 of Chemical Kinetics. /Polanyi, J. C. (ed.). Baltimore; University Park Press (1972).

Work published during 1969 and 1970 is reviewed, with emphasis placed on the quantitative aspects of reactions of radicals containing three or more atoms and in the gas phase, although some relevant solution work is covered. Topics discussed are combination reactions of radicals, disproportionation and combination of radicals, reactions of radicals with NO, NO_2, and O_2, reactions involving abstraction by radicals, including a discussion on reactions of hot radicals, reactions between radicals and olefins, and reactions of carbenes. (255 references) (J.G.B.)

2434 EXPERIMENTAL STUDIES OF HOT ATOM REACTIONS. Rowland, F. S. (Univ. of California, Irvine). pp 109-33 of Chemical Kinetics. /Polanyi, J. C. (ed.). Baltimore; University Park Press (1972).

The following topics are reviewed: sources of hot atoms, reactions initiated by hot atoms, reactions of energetic monovalent atoms, stereochemistry of the substitution process at asymmetric carbon positions, thresholds for atomic reactions, excitation energies of hot reaction products, substituent influences on primary reaction yields, bond energy effects in abstraction reactions, and trajectory calculations of hot atom reactions. (80 references) (J.G.B.)

2435 STUDY OF ^{140}La RECOIL ATOMS IN SOME SOLID LANTHANUM COMPOUNDS USING GAMMA RAY ANGULAR CORRELATIONS. Vasudev, P.; Jones, C. H. W. (Simon Fraser Univ., Burnaby, British Columbia). Radiochim. Acta; 17: No. 3, 121-5(Oct 1972).

An attempt was made to study the chemical effects accompanying internal conversion in the decay of $^{140}Ba \rightarrow ^{140}La$, and accompanying recoil in the nuclear reaction $^{139}La(n,\gamma)^{140}La$, employing the angular correlation of the 329 to 487 keV $\gamma-\gamma$ cascade in ^{140}Ce as a probe. The time integral angular correlation was studied for this cascade, and also for the unperturbable 487 to 1596 keV $\gamma-\gamma$ cascade in ^{140}Ce, which was used as an internal standard in the experiment. The sources studied included $^{140}BaF_2$ (solution), $^{140}BaF_2$ (solid), and neutron irradiated solid samples of LaF_3, $La(NO_3)_3$, La (salicylate)$_3$, and La (benzoylacetonate)$_3$. Recrystallized samples of neutron irradiated compounds were also investigated. For none of these sources was a measurable perturbation ascribable to the chemical effects of the nuclear transformation observed. (auth)

2436 ISOTOPIC AND RECOIL-ENERGY EFFECTS IN SEVERAL CHROMATES AND THALOUS SALTS. Ackerhalt, R.; Harbottle, G. (Brookhaven National Lab., Upton, N. Y.). Radiochim. Acta; 17: No. 3, 126-31(Oct 1972).

A comparison of the detailed annealing reactions ^{51}Cr atoms produced in K_2CrO_4 by n,2n and n,γ reactions demonstrates a high degree of similarity despite the great difference in recoil energies. The results of these and other experiments on the yields of ^{49}Cr-labelled species permit some insight into the relative importance of recoil energy and isotopic effects in the chromates. (auth)

2437 EFFECT OF RARE GAS ADDITIVES ON THE REACTIONS OF ^{11}C ATOMS FOLLOWING $^{12}C(p,pn)^{11}C$ IN SATURATED HYDROCARBON SYSTEMS. Finn, R. D. (Virginia Polytechnic Inst. and State Univ., Blacksburg); Ache, H. J.; Wolf, A. P. Radiochim. Acta; 17: No. 3, 131-4(Oct 1972).

Reactions of energetic carbon atoms produced by the nuclear process $^{12}C(p,pn)^{11}C$ were studied in rare gas moderated and oxygen scavenged by hydrocarbon systems. The yields of the two major reaction products, acetylene-^{11}C and ethylene-^{11}C, decreased with increasing amount of moderator present. The ratio of $H_2{}^{11}C=CH_2/H^{11}C\equiv CH$ varied as a function of moderator concentration, which was consistent with the postulate that a fraction of the acetylene-^{11}C is formed by a process occurring in a higher energy range than is the ethylene-^{11}C. Changes in the carbon monoxide-^{11}C yields as a function of moderator concentration suggest the contribution of an indirect route to total carbon monoxide-^{11}C produced, i.e., via the reaction of intermediate species produced in "hot" carbon atom reactions reacting with molecular oxygen. (auth)

2438 RELATIVE IMPORTANCE OF KINETIC ENERGY AND POSITIVE CHARGE IN THE REACTION OF (I.T.)-ACTIVATED ^{80}Br IN ETHANE WITH VARIOUS MODERATORS. Tachikawa, E.; Yanai, K. (Japan Atomic Energy Research Inst., Tokai). Radiochim. Acta; 17: No. 3, 138-42(Oct 1972).

The major compounds produced by the $^{80m}Br(I.T.)^{80}Br$ reaction in C_2H_6 in the gaseous phase were $CH_3{}^{80}Br$, $C_2H_5{}^{80}Br$, and $CH_2{}^{80}BrBr$. Varying amounts of additives were added to determine the manner in which additives moderate the reaction of ^{80}Br with C_2H_6. The data suggest that the products were mainly formed via kinetic energy processes of ^{80}Br, possibly in a neutral and electronic ground state, but in the presence of large amount of additives, $CH_3{}^{80}Br$, is also formed via a kinetic energy independent process. The isotopic variations between C_2H_6 and C_2D_6 were 1.4 for $CH_3{}^{80}Br/CD_3{}^{80}Br$, 1.6 for $C_2H_5{}^{80}Br/C_2D_5{}^{80}Br$ and 1.4 for $CH_2{}^{80}BrBr/CD_2{}^{80}BrBr$. (auth)

2439 SULFUR DIOXIDE AS A RADICAL SCAVENGER IN ALKENE SYSTEMS. Fee, D. C. (Univ. of California, Berkeley); Markowitz, S. S.; Garland, J. K. Radiochim. Acta; 17: No. 3, 135-8(Oct 1972).

The comparative efficiency of SO_2 and O_2 as radical scavengers was determined in the T + cyclohexene, T + transbutene, and T + n-butane gas phase systems. T was produced by recoil in the $^3He(n,p)T$ reaction. O_2, the only scavenger currently in use in T + alkene systems, causes an anomalous increase in the butadiene-t yield from T + cyclohexene reactions. All other tritiated products from cyclohexene and transbutene + T reaction show similar scavenging trends. The use of SO_2 as a radical scavenger may be advantageous in some alkene systems although SO_2 fails to eliminate all thermal contributions to the HT yield in the T + n-butane system. (auth)

2440 MOESSBAUER BEAM EXPERIMENT AND ITS POSSIBLE APPLICATION IN HOT ATOM CHEMISTRY. Fenger, J. (Danish Atomic Energy Commission Research Establishment, Risoe). Radiochim. Acta; 17: No. 3, 170(Oct 1972).

Reactions of recoil ^{57}Fe and ^{59}Fe were studied by Moessbauer beam experiments. It was concluded that use of this technique in hot atom chemistry is questionable. (M.C.G.)

Properties of Radioactive Materials

Refer also to abstracts 2386 and 2418.

2441 (ARH-SA-100) KINETICS AND MECHANISM OF PLUTONIUM(IV) REDUCTION BY HYDROXYLAMINE. Barney, G. S. (Atlantic Richfield Hanford Co., Richland, Wash. Separations Chemistry Lab.). Aug 1971. Contract AT(45-1)-2130. 27p. (CONF-710913-4). Dep. NTIS.

From 162nd national meeting of the American Chemical Society; Washington, D. C. (12 Sep 1971).

The kinetics of the reduction of plutonium(IV) to plutonium(III) with hydroxylamine were studied in 0.3 to 2.5M nitric acid at an ionic strength of 2.5. The stoichiometry of the reaction was found to vary according to reaction conditions. The moles of Pu(IV) consumed per mole of hydroxylamine range between 1.3 and 1.6, depending on the initial Pu(IV) concentration. The reaction is complex, involving several steps and intermediates. Effects of $[H^+]$, $[NO_3^-]$, $[NH_3OH^+]$, ionic strength, and temperature on the reaction rate were studied. Evidence was obtained which indicates substitution of a nitrate ligand with a neutral hydroxylamine molecule to form the initial activated complex. The initial rate [with no Pu(III) present] is described by the empirical equation, $\{-d[Pu(IV)]/dt\}_{t=0} = \{[Pu(IV)]_0[NH_3OH^+]_0(k_1 + k_2[NH_3OH^+]_0)/[H^+]_0^2 (1 + k_3[NO_3^-]_0)\}$. The fact that addition of Pu(III) markedly decreases the reaction rate indicates that there is a back reaction occurring in which Pu(III) is oxidized by some hydroxylamine-derived intermediate, possibly NH_2O. Mechanisms consistent with the observed kinetics are presented. (auth)

2442 (BLG-463) PREPARATION OF UF_6 ON PILOT SCALE BY DIRECT FLUORIZATION OF UO_2 POWDER. Harnie, R.; Goossens, W.; Ooms, E. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium)). Jun 1972. 32p. (In Dutch). Dep NTIS (U. S. Sales Only).

The experimental research in the pilot installation EBO, built under the reprocessing project, was oriented to the preparation of UF_6 from pulverized UO_2. This preparation was performed by treating the fluidized powder by ClF_3 or F_2. In the first runs, the conversion of a definite reactor load was determined. Afterwards, the installation was adapted in order to be able to perform a continuous exploitation. The chemical data and the technological experience gained during these runs are discussed. (auth)

2443 (GAT-T-1922) FLUORINE DISPOSAL METHODS. Netzer, W. D. (Goodyear Atomic Corp., Piketon, Ohio). 13 Oct 1972. Contract AT(33-2)-1. 25p. (CONF-721030-3). Dep. NTIS.

From Conference on pollution control and abatement at AEC facilities; Oak Ridge, TN. (25 Oct 1972).

Investigations are in progress to determine a safe, economical method of disposing of the fluorine presently vented from a uranium oxide conversion facility. The facility produces uranium hexafluoride by reacting high assay uranium oxides with fluorine, and the selection of a disposal process is complicated by the presence of oxygen in the outlet gases and the geometry constraints imposed by nuclear safety. The disposal processes under consideration include caustic scrubbing, fixed bed reactors and a fluidized bed reactor. A 5-inch inner diameter countercurrent spray tower was built that can absorb 90% of a 3 standard cfm fluorine flow using a 3 gpm flow of 5 wt% KOH. However, the toxic gases oxygen difluoride and nitroxy fluoride are produced in the scrubber. Fixed bed charcoal and iron reactors were operated, but the charcoal reaction produces large quantities of carbon monoxide, carbonyl fluoride, and silicon tetrafluoride; and the iron reaction produces molten iron which plugs the reactor. Experiments in progress with an iron oxide bed appear more promising, but all fixed bed reactor systems are hampered by high maintenance costs, and studies utilizing fluidized bed reactors are now being considered. (auth)

2444 AMINO ACIDS IN CLAY-HUMIC ACID COMPLEX FORMATION. Scharpenseel, H. W.; Kruse, Elisabeth (Univ., Bonn). pp 193-210 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

The special role that amino acids play as bridging units during the formation of clay-organic derivatives in soils is discussed. By radiometric precipitation tests the specific effects of various acid, neutral and basic amino acids on the formation of the clay-humic acid complex were compared through the use of ^{14}C-labeled humic acid and amino acid tracer materials. Double labeling with these ^{14}C compounds and ^{55}Fe chloride or hydroxide reveals the complex forming characteristic relative to that of Fe^{3+}. Thin-layer chromatographic runs in various clay/starch mixtures, with the administered ^{14}C-labeled humic acid, amino acid and ^{55}Fe tracer compounds settling at different R_f distances, demonstrate visibly the formation of immobile clay-organic complexes in dependence on the presence of the labeled materials. (auth)

2445 CO-ORDINATION CHEMISTRY OF TETRAVALENT AND HEXAVALENT URANIUM. Ramamoorthy, S.; Santappa, M. (Univ. of Madras). J. Sci. Ind. Res.; 31: No. 2, 69-94(Feb 1972).

Recent advances in the coordination chemistry of tetravalent and hexavalent uranium ion-ligand systems are reviewed, with particular reference to the preparation and characterization of complexes with organic and inorganic ligands. The various experimental techniques employed for detecting complex species are mentioned. The stabilities of the complexes are considered under the heads: evaluation of formation constants, formation constant data, and evaluation of thermodynamic parameters. Exhaustive data on stability constants of complexes with organic and inorganic ligands are listed. Other aspects covered include: visible and UV spectra, photochemical oxidation, photochemical polymerization and fluorescence quenching of uranyl compounds. Advances towards the understanding of bonding in complex compounds through the interpretation of magnetic, spectral, IR and X-ray data are reviewed. The applications of uranyl complexes in solvent extraction, ion exchange, and analysis are mentioned. (402 references) (auth)

2446 PREPARATION AND CRYSTALLOGRAPHIC STUDY OF THE $Ba_2(UMg)O_6-Ba_2(U_xFe_y)O_6$ SYSTEM. Padel, Liliane; Poix, Paul; Michel, Andre (Paris Univ., Orsay, France). Rev. Chim. Miner.; 9: No. 2, 337-50(1972). (In French).

The distribution of U, Mg, and Fe cations in the 4a and 4b octahedral sites of this ordered perovskite structure was studied. It was shown that substitution mechanisms greatly reduce the distortion at these positions. (France)

2447 ADSORPTION OF HYDROLYZABLE METAL IONS AT THE OXIDE-WATER INTERFACE. II. CHARGE REVERSAL OF SiO_2 AND TiO_2 COLLOIDS BY ADSORBED Co(II), La(III), AND Th(IV) AS MODEL SYSTEMS. James, Robert O.; Healy, Thomas W. (Univ. of Melbourne). J. Colloid Sci.; 40: No. 1, 53-64(Jul 1972).

The detailed electrophoretic mobility behavior, supplemented by streaming potential data, for SiO_2 in aqueous solutions of Co(II), La(III), and Th(IV) was determined as a function of metal ion concentration, pH, ionic strength, and percentage solids. The several charge reversals (CR) observed are, in order of increasing pH, shown to represent the point-of-zero charge (PZC) on the SiO_2 substrate (CR 1), the pH of surface nucleation of metal hydroxide (CR 2), and at high pH, the PZC of the metal hydroxide coating (CR 3). (auth)

2448 OXIDATIVE DEMETHYLATION OF TOLUENE, USING BISMUTH URANATE AS OXIDANT. De Jong, J. G. S.; Guffens, C. H. E.; van der Baan, H. S. (Univ. of Tech., Eindhoven, Netherlands). J. Catal.; 26: No. 3, 401-15(Sep 1972).

When brought into contact with various bismuth uranates in a stream of an inert gas at 400 to 500°C, toluene is oxidized to benzene, CO_2, and H_2O. The best benzene yields are obtained using the compound Bi_2UO_6 with a high specific surface area. A fixed percentage of the oxygen atoms present in this compound gives rise to a rapid total combustion of the toluene. After consumption of these atoms, toluene is converted into benzene with

a selectivity up to 70%. During this process bismuth uranate can lose 60% of its oxygen atoms, corresponding to zero-valent bismuth and tetravalent uranium. The original activity is completely restored by oxidation with molecular oxygen. This opens the possibility of demethylating toluene by passing air and toluene alternately over bismuth uranate. The kinetics of the reaction between toluene and bismuth uranate, investigated in micropulse and microflow systems and in a thermobalance, are complicated. The surface reaction appears to be first order in toluene with an energy of activation of 30 kcal mole^{-1} at 480°C but the transport rate of oxygen from the bulk of the Bi_2UO_6 matrix to the surface also plays a role. The selective reaction is likely to occur via a benzoate-like intermediate. The reoxidation of reduced bismuth uranate with air is very fast, and even proceeds at 100°C. (auth)

2449 INVESTIGATIONS ON THE EASE OF DECONTAMINATION OF COATING MATERIALS. Berger, W.; Hepp, H.; Sauermann, P. F. Farbe Lack; 76: No. 1, 44-9(1970). (In German).

The decontaminability of 22 protective coatings produced under the same conditions at two places independent from each other was determined. Best results were obtained with silicon resin varnishes, two-component polyurethane varnishes and coatings, and with chloro- and cyclocaoutchouc coatings. The decontaminability seems to be a specific property of the binder which can be used for other kinds of contaminations if the protective coating is chemically stable against the attacking medium. (GF)

2450 VOLTAMMETRIC INVESTIGATION OF THE NEPTUNYL GLYCINATE COMPLEX AT THE ROTATED GLASSY CARBON ELECTRODE. Plock, C. E. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Electroanal. Chem.; 22: 185-93(1969). (RFP-1219).

The voltammetric behavior of neptunium(VI)–glycinate complex was investigated over widely varying conditions of ligand concentration and pH. Under all the conditions investigated, a reversible, one-electron wave corresponding to the reduction of neptunium(VI) to neptunium(V) was obtained. The half-wave potential was found to be independent of the pH in the pH-ranges, 0.1 to 1.0 and 2.7 to 3.8. In the pH-ranges 1.0 to 2.7 and 3.8 to 5.0, the half-wave potential is a function of pH. In each of these pH-ranges except 0.1 to 1.0, neptunium(VI) has one more glycinate ligand bound to it than neptunium(V). The metal : ligand ratio was found to be 1 : 3 and 1 : 4 by conductometric and amperometric titrations. The limiting current is proportional to the concentration of neptunium(VI) from 7.50×10^{-5} to 1.88×10^{-3} M. The diffusion coefficient is $0{:}48 \times 10^{-5}$ cm^2 sec^{-1}. (auth)

2451 CHEMISTRY OF THE TRIVALENT ACTINIDES. 2. URANIUM(III) DOUBLE CHLORIDES AND SOME COMPLEXES WITH OXYGEN-DONOR LIGANDS. Barnard, R.; Bullock, J. I.; Gellatly, B. J.; Larkworthy, L. F. (Univ. of Surrey, Guildford, Eng.). J. Chem. Soc., Dalton Trans.; No. 18, 1932-8(1972).

Two series of hydrated double chlorides were isolated and characterized. Compounds of the red series, $M^IUCl_4 \cdot 5H_2O$ (M^I = K, Rb, or NH_4), have an intense absorption at 18,000 cm^{-1} in their reflectance spectra and in the spectra of their solutions in methanol and 11M hydrochloric acid. There are also bands at 230 and 196 cm^{-1} in the spectrum of $RbUCl_4 \cdot 5H_2O$, which can be assigned to U–Cl stretching vibrations. These electronic and far ir bands are absent from the spectra of the green series, $M^IUCl_4 \cdot xH_2O$ (M^I = Rb or NH_4), as these closely resemble the reflectance spectra of the uranium (III) sulphates and double sulphates and the spectrum of the hydrated uranium(III) ion. In water the red series gave the spectrum of the hydrated uranium(III) ion. Thus the red series is believed to contain co-ordinated chloride while the green compounds contain uranium (III) in a more ionic environment. Owing to the presence of a small amount of M^ICl, the degree of hydration of the green series is uncertain. Corresponding bromides could not be isolated. Like the lanthanide(III) metal ions, uranium(III) forms complexes; $[U(phaz)_6]Cl_3$ or $(Ph_4B)_3$. and $[U(dmaz)_4](Ph_4B)_3$. with the oxygen-donor ligands phenazone (Phaz, 1-phenyl-2, 3-dimethyl-5-pyrazolone) and 4-dimethylaminophenazone (dmaz), which were isolated from alcoholic solutions of the red double chlorides and the ligands. These complexes are readily oxidized by air and water, and this reactivity prevents an extensive study of the complexing ability of trivalent uranium; many other oxygen-donor ligands were investigated but oxidation of the uranium(III) occurred even under nitrogen. (auth)

2452 INFRARED SPECTRA OF THORIUM COMPOUNDS WITH DIMETHYL SULFOXIDE. Petrov, K. I.; Ivanova, O. M.; Molodkin, A. K. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 17: No. 6, 1613-15(Jun 1972). (In Russian).

Infrared absorption spectra in the region 400 to 3,600 cm^{-1} were studied for a series of Th compounds containing from 3 to 12 molecules of dimethyl sulfoxide (DMSO), e.g., $ThCl_4 \cdot 7DMSO \cdot 3H_2O$, $ThI_4 \cdot 12DMSO$, $Th(NO_3)_4 \cdot 3DMSO \cdot 2H_2O$, and $Th(SO_4)_2 \cdot 4DMSO \cdot 9H_2O$. DMSO coordinates with Th through the O atom of the sulfo-group. (K.S.W.)

2453 SPECTROSCOPIC PROPERTIES OF THIOCYANATO-OXALATO COMPOUNDS OF URANIUM. Shchelokov, R. N.; Krasilov, Yu. I.; Karasev, V. E.; Orlova, I. M. (Inst. of General and Inorganic Chemistry, Moscow). Zh. Neorg. Khim.; 17: No. 6, 1705-10(Jun 1972). (In Russian).

Infrared absorption spectra and fluorescence spectra of guanidinium thiocyanato-oxalato compounds of uranium were examined: $M(CH_6N_3)_2[UO_2(C_2O_4)_2SCN] \cdot nH_2O$, where M = K, Rb, Cs, NH_4, or CH_6N_3. Fundamental frequencies were identified, and proposals were made regarding the character of coordination of the thiocyano and oxalate groups and the structure of the complexes. (K.S.W.)

2454 SYNTHESIS OF NEPTUNIUM(IV) AND (V) SULFATES. Mefod'eva, M. P.; Krot, N. N.; Gel'man, A. D. (Inst. of Physical Chemistry, Moscow). Zh. Neorg. Khim.; 17: No. 6, 1711-16(Jun 1972). (In Russian).

The following Np sulfates were prepared from aqueous solutions and confirmed by analysis: (containing Np(V)) $Co(NH_3)_6NpO_6(SO_4)_2 \cdot 3H_2O$; $Co(NH_3)_6NpO_2(SO_4)_2 \cdot Na_2SO_4 \cdot nH_2O$; $Co(NH_3)_6NpO_2(SO_4)_2 \cdot K_2SO_4 \cdot nH_2O$; $(NpO_2)_2SO_4 \cdot 5H_2O$; (containing Np(VI)) $Np(SO_4)_2 \cdot 4H_2O$; $K_4Np(SO_4)_4 \cdot 3H_2O$; $Co(NH_3)_6NaNp(SO_4)_4 \cdot 8H_2O$. Certain properties of these complexes are reported. (tr-auth)

2455 INTERACTION OF NEPTUNIUM(V) WITH DICARBOXYLATE LIGANDS. Magon, L.; Bismondo, A.; Tomat, G.; Cassol, A. (CNR, Padua). Radiochim. Acta; 17: No. 3, 164-7(Oct 1972).

Equilibria involved in the interaction of neptunyl(V) ion and oxalic, malonic, succinic, phthalic, and maleic acids in aqueous solutions were investigated by means of potentiometric measurements of hydrogen ion concentration at 20°C and in an ionic medium 1 M $NaClO_4$. In the pH range examined, the formation of chelate complexes with one and two ligands for the neptunyl(V) oxalate system and with one ligand only for the other systems was ascertained. The formation constants were determined. The stability of the complexes is briefly discussed in correlation with the different basicity and structure of the ligands. (auth)

2456 DESORPTION OF TRACE AMOUNTS OF ^{144}Ce FROM COTTON MATERIAL BY COMPLEXONE III IN AQUEOUS SOLUTIONS. II. Bar, Jaromir (First Brno Engineering Works, Czech.); Kostylek, Jaromir. Jad. Energ.; 18: No. 10, 345-6 (Oct 1972). (In Czech).

The effects of the disodium salt of ethylenediaminetetraacetic acid (Complexone III) (0.05% to 0.50%) were compared with the effects of solutions of NaCl, (1 CH_3COONa + 1 NaCl), and (1 $NaBO_2$ + 1 NaCl), of the same ionic strengths of $\mu = 4 \times 10^{-3}$ to 4×10^{-2}, on the desorption of trace amounts of ^{144}Ce adsorbed on cotton material from aqueous solution of (0.05 M CH_3COONa + 0.05 M NaCl). A high specific desorption effect was found using Complexone III with the pH ≥ 3.5, with a maximum at pH = 4 to 6. (auth)

2457 POTENTIOMETRIC STUDY OF THE CHELATES OF Al(III), Ce(IV), AND Th(IV) WITH ALIZARIN RED-S. Govil, P. K.; Banerji, S. K. (Birla Inst. of Tech. and Science, Pilani, India). J. Chin. Chem. Soc. (Taiwan); 19: No. 2, 83-6(Jun 1972).

The stepwise metal-ligand stability constants of Alizarin Red S chelates with Al^{3+}, Ce^{4+}, and Th^{4+} were determined by using the Bjerrum–Calvin technique. Various computational methods were used to determine the stability constants. Thermodynamic stability constants were also calculated by determining the stepwise stability constants at various ionic strengths and then by extrapolating to zero ionic strength. The order of stability constants was found to be: Th > Al > Ce. (auth)

Radioactive Waste Treatment

Refer also to abstract 2469.

2458 (BNWL-1667) WASTE SOLIDIFICATION PROGRAM SUMMARY REPORT. VOLUME 11. EVALUATION OF WSEP HIGH LEVEL WASTE SOLIDIFICATION PROCESSES. McElroy, J. L.; Schneider, K. J.; Hartley, J. N.; Mendel, J. E.; Richardson, G. L.; McKee, R. W.; Blasewitz, A. G. (Battelle Pacific Northwest Labs., Richland, Wash.). Jul 1972. Contract AT-(45-1)-1830. 529p. Dep. NTIS.

Successful demonstrations of the solidification of high-level radioactive waste by the pot, spray, and phosphate glass solidification processes were performed in WSEP. A total of 33 demonstrations were completed. More than 50 million curies of radionuclides were processed and collected in 6-, 8-, and 12-in. diameter containers. The results of these runs were evaluated and are presented. Results from WSEP were used to develop de-

sign concepts and waste management economics for application of the WSEP solidifiers in industrial plants. Material balance flowsheets were developed and design concepts were made for a 5 tonne/day reprocessing plant for both the high salt, sulfate-containing PW-2 waste, and for the relatively pure fission product PW-4m waste used in WSEP. Economic comparisons of the entire waste management scheme were made. An overall comparison of the WSEP type solidification processes indicated an apparent slight preference of the spray solidification process over pot calcination, with the phosphate glass process having the fewer number of advantages for the cases studied. (auth)

2459 (CEA-R-4335) EFFECT OF ORGANIC MATTER IN A WATER COURSE ON RADIOACTIVE POLLUTION. METHODS OF EXTRACTING, FRACTIONATING, AND IDENTIFYING THE ORGANIC CONSTITUENTS AND THEIR RADIONUCLIDE AFFINITIES. Faure, Jean (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Aug 1972. 63p. (In French). Dep. NTIS (U. S. Sales Only).

The interactions of radionuclides (^{141}Ce, ^{133}Ba, ^{106}Ru, ^{137}Cs, ^{54}Mn, ^{65}Zn, ^{60}Co) with the organic matter extracted from a sediment were studied by extraction, fractionation, and nuclear techniques; these techniques were also applied to soil studies. The results indicate that the organic matter of the sediment under study was mainly constituted by substances of low molecular weights. Some very active groups of these substances (quinone and polycyclic hydroquinone) were observed using spectroscopic analysis methods in the ultraviolet and visible regions. (France)

2460 (EUR-4890) TREATMENT OF RADIOACTIVE LIQUID EFFLUENT. Results of Operations, 1968-1971. Vaccarezza, J.; Vanuzzi, S.; Monfrini, C. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov 1972. 14p. (In French). Dep. NTIS (U. S. Sales Only).

Results are given of the main modifications and improvements made in the Waste Processing Plant at Ispra JRC during the period 1968 to 1971, together with an enumeration of all the residual solutions treated. (auth)

2461 (UJV-2345-Ch) DEVELOPMENT OF CONVENIENT SELECTIVE SORBENTS AND OF AN OPTIMIZED CONTACTOR FOR THE DECONTAMINATION OF RADIOACTIVE WATERS. II. DESIGN OF A CLARIFIER-CONTACTOR TO SEPARATE THE SLUDGE. Napravnik, J.; Verner, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). [nd]. 23p. (In Czech). Dep. NTIS (U. S. Sales Only).

The performance and the operational efficiency of the system was tested on a laboratory-scale, 100 liter/hour contactor unit, designed to decontaminate radioactive waste effluents, using flakes of selective sorbents developed at the Nuclear Research Institute, Rez. Radioactive streams with a pH of about 8 were fed into the contactor, at a rate resulting in a residence time of about 1 hour. The decontamination efficiency of the system for various radionuclides was found to be as follows: 98.5% for ^{90}Sr, using 2 g/liter of activated $BaSO_4$; 99% for ^{137}Cs, using 0.1 g/liter of copper(II) ferrocyanide; 99.8% for $^{90}Sr + ^{137}Cs$, using 1 g/l of $BaSO_4$ + 0.1 g/l of $Cu_2Fe(CN)_6$; and finally 50% for ^{131}I, using 1 g/l of the compound Carboraffin C. The volume contraction in all cases was higher than 99%. Extended runs were made in order to determine the hydrodynamic characteristics of the system. (TTT)

Radioisotope Production

Refer also to abstract 2469.

2462 RAPID RADIOCHEMICAL PROCEDURE FOR FISSION PRODUCT BROMINE. Nuh, F. M.; Slaughter, D. R.; Shihab-Eldin, A. A.; Prussin, S. G. (Univ. of California, Berkeley). Radiochim. Acta; 17: No. 3, 149-53(Oct 1972).

A chemical procedure is described, which provides for the separation of fission product bromine from the other fission products in a period of 3 sec. The procedure is based on the rapid oxidation of bromide by permanganate in sulfuric acid. Bromine yields in the range of 30 to 50% are typical and the radiochemical purity obtained with the procedure was tested through separations of 32-min ^{84}Br and the mixture of 55-sec $^{86,87}Br$. Decontamination factors for iodine and ruthenium are given. Evidence is presented, which indicates that ^{86}Br may have a shorter half-life than the accepted value of 54 sec. (auth)

Reactor Fuel Reprocessing

Refer also to abstract 2349.

2463 (ARH-2420) BATCH SOLVENT EXTRACTION OF ^{233}Pa FROM THORIA DISSOLVER SOLUTION. Schulz, W. W. (Atlantic Richfield Hanford Co., Richland, Wash.). Sep 1972. Contract AT(45-1)-2130. 30p. Dep. NTIS.

Head-end removal of undecayed ^{233}Pa from irradiated thoria dissolver solution is desirable prior to Purex process recovery of ^{233}U and thorium to minimize radiolysis of the tributyl phosphate extractant. A batch solvent extraction process for this purpose is described; the extractant is diisobutyl carbinol (DIBC) diluted (20 vol % DIBC) with normal paraffin hydrocarbon (NPH). This process is specifically intended for operation in single-stage centrifugal contactors and was satisfactorily demonstrated in laboratory-scale centrifugal extraction equipment. (auth)

2464 (ARH-SA-107) DISSOLUTION OF THORIA WAFER FUEL ELEMENTS. Schulz, W. W. (Atlantic Richfield Hanford Co., Richland, Wash. Separations Chemistry Lab.). 1 Jul 1972. Contract AT(45-1)-2130. 42p. (CONF-711009-14). Dep. NTIS.

From Joint meeting of the American Nuclear Society; Miami Beach, Fla. (17 Oct 1971).

Both Hanford Purex plant experience in dissolving thoria wafers and the extensive laboratory dissolution tests that preceded plant application are described and summarized. Sludging, production of thoria fines during acid dissolution, of both unirradiated and irradiated wafers was acceptably low. In standard tests [3 hours in boiling 13M HNO_3 - 0.05M KF - 0.1M $Al(NO_3)_3$] about 0.2% sludge was produced from unirradiated wafers and from 0.2 to 5% from irradiated wafers. Reflecting their favorable sludging characteristics, plant-scale dissolutions of 3-ton charges of wafers were accomplished in only half the time required to dissolve an equal amount of conventional thoria powder. The latter material because of its high density packs so tightly in the bottom of dissolvers that even when air-lift circulators are used to disperse it, only a limited geometric surface area is exposed to attack by the acid dissolvent. (auth)

2465 (DOCKET-50201-133) WEST VALLEY REPROCESSING PLANT. Technical Specification 4.3, Change Request. (Nuclear Fuel Services, Inc., Rockville, Md.). 31 Oct 1972. 16p. Dep. NTIS.

A change to Technical Specification 4.3, Storage Canister Loading and Spacing, of operating license CSF-1 is requested and the safety evaluation in support of this change is given. The specification establishes limits governing fuel distribution in the storage pool. Criticality safety analyses were performed to determine the reactivity effects of reducing the water spacing between canisters from 8 to 4 in. and charging two BWR assemblies to each canister. (M.C.G.)

2466 (JUL-822-CT) DEVELOPMENT OF A METHOD FOR ADSORPTIVE PROTACTINIUM SEPARATION FROM REACTOR FUEL SOLUTION. Coenegracht, O. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Chemische Technologie). Jan 1972. 67p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

A method was developed for the separation of ^{233}Pa from reprocessing solutions by absorption on Vycor glass. The column consisted of stainless steel tubes filled with Vycor glass. The best removal solution proved to be 0.5 M oxalic acid. Results showed that the proposed procedure can remove approximately 98% of the protactinium from reprocessing solutions. For the proposed process, the adsorption capacity was 1.4 mg/g glass at grain sizes between 0.30 and 0.43 mm. The experimental studies yielded all information and data necessary for the design of a technical process facility. (H.B.G.)

2467 SYNERGIC EXTRACTION OF URANIUM WITH THENOYLTRIFLUOROACETONE AND TETRAPHENYLPHOSPHONIUM CHLORIDE. Katsura, Kosho (Ryukyu Univ., Naha, Japan); Shinagawa, Mutsuaki. Nippon Genshiryoku Gakkaishi; 14: No. 3, 100-5(Mar 1972). (In Japanese).

Uranium was synergically extracted using TTA and tetraphenylphosphonium chloride (TPPC). Maximum synergism was observed at pH 6.5 using 5×10^{-3}M TTA and 2×10^{-3}M TPPC. The relation between log D and log [L] revealed that the ratio of uranyl, TTA, and TPPC was 1:4:2. Uranyl tribenzoate, formed in benzoate-benzoic acid media, was also synergically extracted using TTA and TPPC. Maximum synergism was observed at pH 3 using 5×10^{-3}M TTA, 2×10^{-3}M TPPC, and 5×10^{-3}M sodium benzoate (NaB). The plot of log D and log [L] showed the ratio of uranyl, benzoate, TTA, and TPPC to be 1:3:2:3. (auth) (Japan)

2468 EXTRACTION OF URANIUM(IV) FROM AQUEOUS NITRIC ACID SOLUTIONS WITH THE QUATERNARY AMMONIUM SALT HYAMINE-1622. Schmid, E. R.; Juenger, E. (Univ., Vienna). Radiochim. Acta; 17: No. 3, 153-8(Oct 1972). (In German).

The distribution of uranium(IV) between aqueous nitric acid solutions and solutions of the quaternary ammonium salt Hyamine-

1622 (=p-diisobutylphenoxyethoxyethyldimethylbenzylammonium as nitrate), using various organic solvents, is described. Uranium(IV) is well extracted. The influence of a number of factors on the uranium(IV) distribution ratio was investigated systematically. In the organic phases, uranium(IV) was present always as a hexanitrato complex. (auth)

2469 LABORATORY STUDIES ON PROMETHIUM RECOVERY AND PURIFICATION FROM FUEL REPROCESSING WASTE SOLUTIONS. Shukla, J. P.; Chandrasekharan, E. S.; Rengan, K.; Ramaniah, M. V. (Bhabha Atomic Research Centre, Trombay, India). Radiochim. Acta; 17: No. 3, 146-9(Oct 1972).

Results of experiments carried out to develop a simple procedure for the recovery of ^{147}Pm from fuel reprocessing wastes are described. The use of adsorption on MnO_2 to separate Pm from the majority of gamma emitters in the reprocessing waste is described. Final purification of Pm from other rare earth constituents was achieved with an anion exchange column using a 20% 7M HNO_3 – 80% CH_3OH (v/v) mixture as eluant. (auth)

ENGINEERING

Energy Conversion

Refer also to abstracts 2650 and 4254.

2470 (BNL–16979) ECOLOGIST'S PERSPECTIVE ON ELECTRICAL POWER. Woodwell, G. M. (Brookhaven National Lab., Upton, N. Y.). [nd]. 10p. (CONF-720124–1). Dep. NTIS.

From Conference on power; Johnson, VT. (Jan 1972).

Methods of fitting human activities into the finite limits of the world environment are discussed with emphasis on the basic laws of ecology. It is noted that the energy used in technology should not exceed regionally the energy available through net production of the mature natural vegetation. (J.R.D.)

2471 (CEA-CONF–2059) EFFECTS OF IRRADIATION ON CONSTITUENT MATERIALS OF THERMOELECTRIC CONVERTERS. Francois, B.; Sainfort, G.; Delmas, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 25 May 1972. 20p. (In French). (CONF-720613–4). Dep. NTIS (U. S. Sales Only).

From third international conference on thermionic electrical power generation; Juelich, Germany (5 Jun 1972).

The major problems which occur in the various parts of a thermoelectric converter under the envisioned operational conditions are reviewed. Particular attention is paid to radiation effects on the principal components of the converter, e.g., the fuel, the conducting tube, the collector, and ceramic insulators. (tr-auth)

2472 (SGAE–2030) PRODUCTION OF ELECTRICITY FROM NUCLEAR ENERGY; FISSION PRODUCT SUPPLY AND EFFECT ON THE ENVIRONMENT. Gruemm, H. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). Jul 1972. 21p. (In German). (CONF-720654–1). Dep. NTIS (U. S. Sales Only).

From Conference of the Electricity Production Association; Salzburg, Austria (Jun 1972).

The annual energy requirements of the world through 1980 are projected. Also given are energy sources such as coal, oil, and hydrodynamics. Based on the projection of CO_2 production, concentrations in the atmosphere are estimated and their possible effect on global temperature is analyzed. Fossil fuels are discussed with respect to environmental pollution through SO_2, NO, CO, hydrocarbons, and dust. World projections are made through the year 2100 for raw materials, food supply, population, industrial production, and environmental pollution. The projections are made for the case of continuation of the present trend as well as for the case of rigorous stabilizing methods starting in 1975. Against this background, the role of nuclear energy is discussed. Public education is emphasized to overcome excessive fears of possible hazards from nuclear power plants. (H.B.G.)

2473 SOLAR ENERGY: THE LARGEST RESOURCE. Hammond, Allen L. Science; 177: No. 4054, 1088-90(22 Sep 1972).

The potential of solar energy for solving the worlds energy problem is briefly discussed. Systems for utilizing solar energy for heating and air conditioning of homes and electricity production are presented. (T.F.D.)

2474 WORLD PROSPECTS FOR NATURAL RESOURCES. Some Projections of Demand and Indicators of Supply to the Year 2000. Fisher, J. L.; Potter, Neal. Washington, D. C.; Resources for the Future, Inc. (1964). 77p. Johns Hopkins Press, Baltimore.

Information and discussions on natural resources are presented in chapters on resource adequacy, resources in the U.S., world trends in resources, projection of resource demands, reserves and supply possibilities, and overall estimations. (J.R.D.)

2475 GRAPHICAL VIEW OF ENERGY SUPPLY AND DEMAND. McKetta, John J. (Univ. of Texas, Austin). Chem. Eng.Progr.; 68: No. 10, 24-8(Oct 1972).

Data are presented graphically which show that the US cannot meet the energy demands between now and 2000 A.D. Recommendations are included on methods of meeting the energy crisis. (J.R.D.)

2476 RADIOVOLTAIC ELECTRIC GENERATOR. Bomal, Robert; Manin, Ange (to Commissariat a l'Energie Atomique). French Patent 2,104,663. 21 Apr 1972. Filed 28 May 1970. (In French).

A voltaic effect electric generator in which the charged particles are provided by a tritium source, is described. The photovoltaic cell is in the form of a thin semiconducting polycrystalline layer (CdTe, ZnTe, or CdS). The tritium source is integrated into the semiconductor. The generator can be constructed in the form of a stack of modules, each module consisting of a source and a cell. Successive modules are separated by an electrically insulating layer. This type of generator has a considerably greater lifetime than photovoltaic effect type generators. No elaborate shielding is required and a yield at least equal to that obtained with other types of generator is ensured. The tritium source can be replaced by a ^{63}Ni source (120 years, $E(\beta) = 67$ keV). (France)

2477 MEASUREMENT OF INSULATION IN A MAGNETOHYDRODYNAMIC GENERATOR UNDER OPERATING CONDITIONS. Beloglazov, A. A.; Kirillov, V. V.; Panovko, M. Ya.; Sokolov, Yu. N. (Inst. of High-Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 10: No. 1, 131-4(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 157-60(1972).

A method for measuring the insulating resistance of the elements of a magnetohydrodynamic generator under operating conditions is proposed. The experimental determination of the insulating resistance of the elements of a hydrodynamic generator in a U-02 unit is described. The values of the insulating resistance, obtained by various methods, are compared. (auth)

2478 ENERGY TRANSMISSION, ENERGY STORAGE, AND LOW TEMPERATURES. Heinz, W. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 17: No. 11, 579-86(Nov 1972). (In German).

For long term planning of electric energy supply, an ever-increasing role is played by the site problem, and, thereby, by the problems of both energy transmission and storage. Especially for the supply of large population centers, special measures must be taken because of lack of necessary space for lines of very high power densities. As solutions to these problems, possibilities of low temperature and supraconduction technology were examined. This technology lies presently beyond the boundaries of economy with respect to energy storage. In special cases of energy transmission, especially in research installations, the technology already is useful and economical. (tr-auth)

2479 ELECTRICAL EFFICIENCY OF A TWO-ELECTRODE CELL WITH A FISSION-FRAGMENT EMITTER. Kostritsa, A. A.; Magzumova, V. S.; Okolovich, V. N.; Takibaev, Zh. A.; Chekushina, L. V. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 6, 42-5(1971). (In Russian).

An ideal cell for direct conversion of fission fragment energy into electrical energy is discussed. The maximum efficiency of such a cell was determined for various geometric forms and in consideration of different systems of retardation of the fragments. These included cells in the forms of a plane condenser, a spherical condenser, and a cylindrical condenser. (K.S.W.)

Facilities and Equipment

Refer also to abstracts 2939, 3954, 3955, and 4708.

2480 (K-L–6295) METHODS FOR COMPARING THE PERFORMANCES OF DIFFERENT TYPES OF COMPACT SURFACES. Cox, B.; Jallouk, P. A. (Oak Ridge Gaseous Diffusion Plant, Tenn.). 1972. 30p. (CONF-721112–2). Dep. NTIS.

From American Society of Mechanical Engineers Winter meeting; New York, NY. (26 Nov 1972).

Methods are presented for evaluating the performances of compact surfaces based on their simultaneous heat transfer rates and pumping power expenditures. Calculations of approximate total costs and volume requirements for a heat exchanger are simplified with the aid of performance curves based on a unit of heat transfer surface area and a unit of exchanger volume. In certain cases, the minimum cost surface can be determined from a single plot and requires no specific cost information. Basic design data are presented for three plate-fin surfaces, each one having a different degree of heat transfer promotion. The attractiveness of each type of surface is shown to depend on the particular design specifications. (auth)

2481 REDUCTION AND HYDROFLUORINATION REACTORS (14 Dec 1960) (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). (CAPE–2214).

2 drawings.

Fluidized-bed reduction and hydrofluorination reactors for use in the green salt plant are described. In the reduction reactor UO_3 is converted to UO_2 by reactions of the UO_3 with H at 900 to 1000°F. This reactor is fabricated from a seamless stainless steel pipe. It is designed to withstand a pressure of 20 psig and a temperature of 1100°F. The hydrofluorination reactor converts UO_2 to UF_4 by the reaction of UO_2 with HF at 800°F. This reactor is designed for a temperature of 800°F and a pressure of 20 psig. A 2 hp motor operates a stirrer at 50 rpm. Both of these reactors are used to process U containing a maximum of 5% ^{235}U. (F.S.)

2482 INDUCTION MOTOR TEMPERATURE MONITORING APPARATUS (30 Sep 1970) (Engineering Materials). (Goodyear Atomic Corp., Portsmouth, Ohio). (CAPE-2223).

2 drawings.

Internal hot-spot temperatures of induction motors used in a gaseous diffusion cascade is approximated by measuring the motor exhaust air stream temperature with thermocouples arranged in a portable matrix and inserted under the motor in the exhaust air stream. This apparatus consists of a tubular Al rack with cross arms of minimal facial area designed to fit snugly between the motor mounting pads. Sixteen copper-constantan thermocouples are installed in a matrix which traverses the total exhaust air passageway. A rotary twenty-position switch, located on the rack, scans the thermocouples. A digital thermocouple indicator is used as a monitor. The apparatus does not need an ice bath reference junction. In testing the apparatus with 2000 hp motors, the standard deviation was found to be ±8.8°F and a deviation of ±5.6°F was found for 450 hp motors. (F.S.)

2483 EVAPORATOR FOR REMOVING WATER FROM URANYL NITRATE HEXAHYDRATE SOLUTIONS (Engineering Materials). (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). (CAPE-2249).

3 drawings.

A slightly modified version of a commercially-available thin-film evaporator is used to remove water from a solution of $UO_2(NO_3)_2 \cdot 6H_2O$. A rotor operating at 1000 rpm maintains a thin film of solution on the wall of the jacketed section. Steam is applied to the jacket at about 100 psig. Concentrated liquid collects in a 4 in. receiver located below the evaporator. The solution is recirculated to the evaporator, using an airlift, until the desired concentration is reached. Air to the airlift enters through a $\frac{1}{4}$ in. coupling. A constant liquid level is maintained in the receivers by internal piping providing the submergence required for satisfactory operation of the airlift and the improvement of the homogeneity of the concentrated solution before the solution is drained to the next vessel. The evaporator is designed for 150 psig steam pressure and has a heat transfer area of 4.5 ft^2. The maximum design temperature is 400°F. The calandria for the evaporator is fabricated of 40 gage Type 347 stainless steel pipe. It must withstand a hydrostatic test pressure of 225 psig and a working pressure of 150 psig. All welds are Type 347 stainless-steel Heliarc. (For details see TID-4100 Suppl. 72) (F.S.)

2484 SYSTEM FOR TEMPORARILY PACKAGING SAMPLES PRIOR TO THEIR IRRADIATION USING A LINEAR ACCELERATOR. Engelmann, C.; Fortin, M. (to Commissariat a l'Energie Atomique). French Patent 2,104,982. 28 Apr 1972. Filed 14 Sep 1970. (In French).

A system for packaging samples prior to their irradiation with γ radiation produced by bombarding a Pt target with electrons from a linear accelerator is described. The sample-holder cartridges are made from elements which are mounted together. The samples which are to be irradiated are put into the cartridges. After the cartridges have been irradiated, they are dismantled and the irradiated sample is removed. (France)

2485 LIQUID METAL COOLED CELL. Descleve, P.; Le Frere, J.-P. (to Groupement Atomique Alsacienne Atlantique). French Patent 2,108,149. 19 May 1972. Filed 29 Jul 1970. (In French).

A cooling cell for a part exposed to a heat flux is described. This cell possesses at least one tube containing a liquid metal coolant. It is provided with a heat exchanger having a form and size suitable for use in conjunction with the part and a section in which liquid metal flows at a rate determined by the quantity of heat to be eliminated. The thickness of the wall of the surface exposed to the heat flux is reduced in such a way as to ensure that the temperature gradient between this surface and the liquid metal flowing inside the heat exchanger is minimized. This device can be used to cool targets used in x-ray or neutron generating equipment. (France)

Heat Transfer and Fluid Flow

Refer also to abstracts 2480, 2485, 2646, 2647, 4406, 4419, 4426, 4429, 4430, and 4757.

2486 (AEC-tr-7366) OPTIMIZING OF INDIRECT HEAT CONDUCTORS. Liesch, K. (Technische Universitaet, Munich (West Germany)). Translated by W. J. Grimes from report MRR-85a. 44p. Dep. NTIS.

The simulating capability of an indirect heat conductor is substantially influenced by the physical properties of the filler material and the heating tube material, and by the position and thickness of the heating tube within the heat conductor, as well as by coefficients of gap heat throughput. These parameters are investigated in detail. Because of the multiplicity of possibilities of variation, only two fillers (MgO, BN) and two heating tube materials (Cr-Ni steel, Cu) were utilized. Moreover, variations of geometry of the heating tube were made, with fixed gap heat throughput coefficient, and variations of the coefficient with fixed geometry were likewise investigated. A possibility for the building of an indirect heat conductor was shown, in which a relative error of only 15% in the simulation of the surface heat flux density and of the temperature characteristic of the sheathing tube occurs. (auth)

2487 (AECL-4263) FLUID TO FLUID MODELING CRITERIA FOR TWO-PHASE PRESSURE DROP. Bruce, J. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug 1972. 38p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

There is a strong economic incentive to model the coolant in boiling-water nuclear reactors using a fluid which requires a reduced power input for a given evaporation rate. To this end an experimental facility capable of testing full-size reactor hardware using Freon as a coolant has been installed at the Chalk River Nuclear Laboratories. In this work, modeling criteria for the two-phase pressure drop have been developed through dimensional analysis and the technique of compensated distortion. To overcome the problem of multiple distortion, a modeling parameter is suggested which is a function of Reynolds, Froude, and Weber numbers and a group identified as the property index. A reduced two-phase Euler number is defined as the dependent variable. Experiments based on the suggested modeling criteria have not yet been performed and it would be precipitous to claim complete generality. However, by adopting the analogy between heat and momentum transfer, compatibility is demonstrated with the work of others. (auth)

2488 (CEA-R-3049) OSCILLATORY BEHAVIOR OF HEATED CHANNELS: AN ANALYSIS OF THE DENSITY EFFECT. PART I. MECHANISM (NON-LINEAR ANALYSIS). Boure, Jean (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Sep 1966. 40p. (In French). Dep. NTIS (U. S. Sales Only).

The problem of the oscillatory behavior of heated channels is presented in terms of delay-times and a density effect model is proposed to explain the behavior. The density effect is the consequence of the physical relationship between enthalpy and density of the fluid. Non-linear equations are derived from the model in a dimensionless form. A description of the mechanism of oscillations is given, based on the analysis of the equations. An inventory of the governing parameters is established. At this point of the study, some facts in agreement with the experiments can already be pointed out. (auth)

2489 (EURFNR-1007) PHENOMENOLOGICAL INVESTIGATIONS INTO FLOW DISTRIBUTION BEHIND LOCAL COOLANT CHANNEL BLOCKAGES IN ROD BUNDLES. Basmer, P.; Kirsch, D.; Schultheiss, G. F. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Reaktorentwicklung). Jan 1972. 36p. (KFK-1548). Dep. NTIS.

Work performed under United States-Euratom Fast Reactor Exchange Program.

The hexagonal case of a SNR-subassembly has been symmetrically divided between two corners. Closing this part by a Plexiglas plate the observation of the flow behavior was possible. The experiments were performed with water and air bubbles as flow indicators. In all experiments a coherent region of 41% of the flow area was completely or partially blocked. Different positions of the blockage, the influence of the spacer grid, the pin bundle, and the wall structure of the Plexiglas upon the turbulence downstream of the blockage have been investigated for two Reynolds numbers. A reduced fluid flow rate within the blocked region was accomplished by drilling narrow holes through the blockage. The main results were:

the dimensions of the turbulence were practically independent of the Reynolds number within the investigated range, even in a pin bundle a distinct recirculation flow develops in the turbulent region; and a fluid flow within the blocked region of about 15% of the whole flow rate destroys the recirculation zone in the wake behind the blockage. (auth)

2490 (FRNC-CONF-44) PUMPING OF SODIUM: PROBLEMS ENCOUNTERED IN MECHANICAL PUMPS. Guer, M. (Societe d'Exploitation des Materiels Hispano-Suiza, Bois-Colombes (France)); Guiton, P. 1972. 6p. (In French). (CONF-720648-7). Dep. NTIS (U. S. Sales Only).

From 12th meeting on hydraulics; Paris, France (6 Jun 1972).

The different sodium pumps used in fast reactors are described (primary and secondary pumps, pumps for integrated circuits). The technological problems involved (such as sodium bearings and thermal shock loads) are due to the properties of liquid sodium. (France)

Materials Testing

Refer also to abstracts 2886, 2917, 2942, 3001, 3011, 4440, and 4740.

2491 (CONF-721024-1) QUALITY ASSURANCE FOR RISK CONTROL AND ENGINEERING VERIFICATION. Bender, M. (Oak Ridge National Lab., Tenn.). [nd]. 16p. Dep. NTIS.

From 32nd national conference of the American Society for Nondestructive Testing; Cleveland, OH. (16 Oct 1972).

The aim of quality assurance is to make certain that engineering actions are controlled in accord with the objectives of the sponsor. The controls must have meaningful engineering purpose to have quality assurance value, and they must be geared to meet suitable engineering risk criteria. These controls are normally based on experience and custom, and they make maximum use of standards. The quality assurance system itself serves a policing function, but it must be balanced in such a way that all participants share in its benefits as well as its disciplines. Documentation is used as a tool for auditing the engineering controls and for identifying problem areas. When the quality assurance system has the confidence of the engineering organization responsible for the work and has commensurate value for all participants, it will be an effective tool for attaining the objectives of the engineering sponsor. (auth)

2492 (ORNL-4553) THEORETICAL AND EXPERIMENTAL STRESS ANALYSIS OF ORNL THIN-SHELL CYLINDER-TO-CYLINDER MODEL NO. 1. Corum, J. M.; Bolt, S. E.; Greenstreet, W. L.; Gwaltney, R. C. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 228p. Dep. NTIS.

The first in a series of four thin-shell cylinder-to-cylinder models was tested, and the experimentally determined elastic stress distributions were compared with theoretical predictions obtained from a thin-shell finite-element analysis. The models in the series are idealized thin-shell structures consisting of two circular cylindrical shells intersecting at right angles. There are no transitions, reinforcements, or fillets in the junction region. The series of model tests serves two basic purposes: (1) the experimental data will provide design information directly applicable to nozzles in cylindrical vessels, and (2) the idealized models serve a basic need for test results for use in developing and evaluating theoretical analyses applicable to nozzles in cylindrical vessels and to thin piping tees. The cylinder of the model tested had an outside diameter of 10 in., and the nozzle had an outside diameter of 5 in., giving a d_0/D_0 ratio of 1/2. The OD/thickness ratio for both cylinder and nozzle was 100. Thirteen separate loading cases were analyzed. In each, one end of the cylinder was rigidly held. In addition to an internal pressure, three mutually perpendicular force components and three mutually perpendicular moment components were individually applied at the free end of the cylinder and at the end of the nozzle. The experimental stress distributions for each of the 13 loadings were obtained using 322 three-gage strain rosettes located on the inner and outer surfaces. Each of the 13 loading cases was also analyzed theoretically using a finite-element shell analysis developed at the University of California, Berkeley. The analysis used flat-plate elements and considered five degrees of freedom per node in the final assembled equations. The comparisons between theory and experiment show reasonably good general agreement, and it is felt that the analysis would be satisfactory for most engineering purposes. (auth)

2493 CRITICAL THOUGHTS ON STRUCTURAL MECHANICS AND NDE. Zisfein, M. B. (Smithsonian Institution, Washington, D. C.); Tarpley, William B. Int. J. Nondestruct. Test.; 4: No. 2, 95-117(Sep 1972).

An evaluation of nondestructive evaluation technology is presented. Discussions are included on nondestructive methods, research and development, and challenges in nondestructive testing development. (J.R.D.)

2494 APPLICATIONS OF DYNAMIC PHOTOELASTICITY IN FLAW DETECTION ANALYSIS. Rose, J. L.; Mortimer, R. W.; Chou, P. C. (Drexel Univ., Philadelphia). Mater. Eval.; 30: No. 11, 242-7(Nov 1972).

An introduction is presented on an experimental procedure in wave propagation that can be used to provide insight into the development of procedures necessary for the evaluation of complex pulse-echo signals and reflection patterns from flaws of odd shape and location. Dynamic photoelasticity is used to obtain a full field view of the reflection patterns of a plane wave impinging on flaws of known shape and location in thin plates. Wave profiles in several layered composite material models were also studied. The information obtained from these studies is applied to sonic field measurements in a specimen with and without a cylindrical flaw. It is shown that dynamic photoelasticity can be used to generate wave speed and profile data that is useful in understanding both transient composite material behavior and basic concepts of nondestructive evaluation. (auth)

2495 EXPERIMENTS WITH ^{241}Am–^{242}Cm–Be FOR NEUTRON RADIOGRAPHY. Barton, J. P.; Klozar, M. F. (Argonne National Lab., Ill.). Mater. Eval.; 30: No. 11, 236-41; 247(Nov 1972).

Experiments were performed to evaluate the potential of the neutron source ^{241}Am–^{242}Cm–Be for neutron radiography, and to compare H_2O and BeO as moderator materials for use with this source. Radiographic exposure data are presented for a range of collimator ratios using dysprosium transfer and LiF-ZnS scintillator direct neutron radiography. The source of yield 1.1×10^9 n/s was found to be capable of providing neutron radiographs with direct-method exposure times ranging from 2 min (10 : 1 collimator) to 60 min (30 : 1 collimator). Water and beryllium oxide moderators were comparable in performance. (auth)

2496 APPARATUS USING EDDY CURRENTS TO DETECT DEFECTS IN METALLIC JOINTS IN AN ELECTRICALLY CONDUCTING TUBE. Dufayet, J.-P. (to Commissariat a l'Energie Atomique). French Patent 2,105,110. 28 Apr 1972. Filed 28 Sep 1970. (In French).

A process utilizing eddy currents to detect defects and other characteristics of metallic joints in an electrically conducting metallic tube is presented. The apparatus used is described, particular emphasis being given to an apparatus intended for detecting faults in joints in which liquid Na is transferred around fuel elements. Voltage variations due directly to variations in the intensity of the eddy currents and frequency variations are measured as a function of the abscissa of the tube. The variations in voltage as a function of the frequency of the eddy currents were also determined. The apparatus consists of a coil wound around the electrically conducting tube containing the joint to be studied. It is along this tube that the eddy currents are developed. A second coil is wound around this tube. This coil acts as the inductance of a Hartley oscillator circuit and also as the current detection coil. The apparatus is provided with a double channel recorder and a recorder which supplies curves of the variations in potential and frequency (parametric curve). (France)

2497 APPARATUS FOR THE QUALITY CONTROL AND AUTOMATIC SELECTION OF METALLIC TUBES. Dufayet, J.-P.; Le Bot, M.; Stossel, A. (to Commissariat a l'Energie Atomique). French Patent 2,105,337. 28 Apr 1972. Filed 1 Sep 1970. (In French).

An apparatus for the quality control and automatic selection of stainless steel tubes intended for cladding nuclear reactor fuel elements is described. It consists of an eddy current quality control apparatus through which the tubes are passed. The tubes produce an electrical signal, which for a given constant velocity corresponds to a frequency spectrum characteristic of the nature and extent of the tube defects. (France)

Nuclear Explosions

Refer also to abstract 2328.

2498 (EERL-MP-E-72-2) CRATERS AS ENGINEERING STRUCTURES. Day, Walter C. (Army Engineer Waterways Experiment Station, Livermore, Calif. (USA). Explosive Excavation Research Lab.). 3 Jul 1972. 54p. (CONF-721108-1). Dep. NTIS.

From PNE panel meeting; Vienna, Austria (26 Nov 1972).

The results of studies and field investigations of the zones and

physical properties of explosively produced craters are summarized. Field investigations of the six U. S. nuclear craters, Danny Boy, Sedan, Sulky, Cabriolet, Buggy, and Schooner, and of many chemical explosive craters have been carried out. These investigations were conducted to determine such properties as: (1) geometry of the apparent crater, the true crater, and the rupture zone; gradation or size distribution of the broken material in the rubble zone; bulk density, bulking factor, and porosity of the rubble and the rupture zones; degree and orientation of blast fracturing and permanent displacements in the rupture zone; mass strength of rubble and rupture zone materials; and compressibility of rubble and rupture zone materials (settlement). Data gathered in these field investigations have been used in studies and laboratory research dealing with the evaluation of explosively produced craters as engineering structures. The most important questions in an engineering analysis of craters deal with the subjects of stability of the crater slopes, water seepage and groundwater conditions, and settlement of rubble zone materials. These subjects have direct bearing on the suitability of craters as canals and water conveyance channels, harbors, reservoirs, road cuts and other engineering structures. Slope stability analyses have received by far the most attention because of the necessity to assess the stability of large crater slopes considered in the proposed design of a nuclear interoceanic sea-level canal. All conditions relating to the possible failure of crater slopes have been studied including material properties, geologic structure, seepage and groundwater conditions, and seismic loading. It was found that, with good permeability data, hydraulic conditions can be accurately modeled by the finite element technique. The method allows direct determination of seepage rates, seepage pressures, and the position of the free water surface for steady state flow conditions. Parameter studies with several assumed permeability conditions were investigated. Testing for mechanical properties of fallback material was first tried on the sandstone and shale material from an explosively excavated railroad cut. Laboratory test data include particle gradation, strength, and compressibility characteristics. Compaction tests were conducted in the field under both dry and wet conditions. The general assessment is that an explosively produced crater is initially stable and that, unless some adverse condition develops because of changes in material properties or hydraulic conditions with time, it will remain stable. The basic problem then is to be able to predict changes and to assess the consequences of these changes. (auth)

2499 (NOAA-TM-ERL-ESL-19) OLD RELIABLE MINE PROJECT SEISMIC MEASUREMENTS. Navarro, Richard (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Earth Sciences Labs.). Jul 1972. 21p.

The 4-million lb. Old Reliable Mine chemical explosion with a body-wave magnitude (m_b) of 4.5 was recorded by 12 temporary velocity seismograph stations operated by the Nevada Special Projects Party. The detonation occurred on Mar. 9, 1972, at 184500 GMT. The Old Reliable Mine is located 44.5 mi northeast of Tucson, Arizona. The stations ranged in distance from 2.00 km to 61.80 km. Due to low ground-motion predictions most of the data channels were saturated on the peak amplitudes. The attenuation rate of the observed peak ground-motion velocity amplitudes varied as the 1.86 power of the distance. The propagational velocities of the compressional waves were 4.9 km/sec for the direct P-phase and 7.7 km/sec for the refracted P/phase. (auth)

2500 (NVO-746-5) PRELIMINARY SEISMICITY STUDY OF THE SOUTHERN NEVADA REGION FOR THE MONTH OF AUGUST 1972. Bayer, K. C.; King, K. W. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Earth Sciences Labs.). Oct 1972. Contract AT(29-2)-746. 20p. Dep. NTIS.

A cooperative (ESL, Sandia Laboratories, USGS) network of 21 seismic velocity sensitive stations is operated in the southern Nevada area; the stations are monitored by the NOAA/ESL Nevada Special Projects Party located in Las Vegas, Nevada. There was no significant earthquake pattern that developed during the month of August 1972. Two seismicity maps are included; one of the southern Nevada region and the second of the seismicity on the Nevada Test Site (NTS). (auth)

2501 (NVO-746-TM-4) REFRACTION SURVEYS IN RIFLE, COLORADO. Navarro, Richard; Bayer, K. C.; King, K. W. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Earth Sciences Labs.). Jun 1972. Contract AT(29-2)-746. 22p. (NOAA-TM-ERL-ESL-18). Dep. NTIS.

The thickness of the low-velocity layer (V_1) and the propagational velocities of the first two surface layers vary considerably throughout Rifle, Colorado. The thickness of the low-velocity layer was found to range from 6 ft to 29 ft. The apparent propagational velocities of the first (V_1) and second (V_2) layers varied from 1000 to 2000 ft/s and from 1790 to 12,000 ft/s, respectively. The apparent dip of the $V_1 - V_2$ interface was less than 4° in every instance. (auth)

2502 (NVO-756-7) PRELIMINARY SEISMICITY STUDY OF THE SOUTHERN NEVADA REGION FOR THE MONTH OF SEPTEMBER 1972. Bayer, K. C.; King, K. W. (National Oceanic and Atmospheric Administration, Las Vegas, Nev. Earth Sciences Labs.). Nov 1972. Contract AT(29-2)-746. 24p. Dep. NTIS.

A cooperative (ESL, Sandia Laboratories, USGS) network of 21 seismic velocity sensitive stations is operated in the southern Nevada area; the stations are monitored by the NOAA/ESL Nevada Special Projects Party located in Las Vegas, Nevada. A significant increase in seismic activity on the Nevada Test Site (NTS) was observed following two nuclear explosions in the Yucca Flat area. Two seismicity maps are included; one of the southern Nevada region and the second of the seismicity on the NTS. (auth)

2503 (SC-RR-720517) AIRBLAST FROM SEQUENCED EXPLOSIONS OF CHARGES HORIZONTALLY DISPERSED IN THREE VERTICAL LAYERS. Vortman, L. J. (Sandia Labs., Albuquerque, N. Mex.). Oct 1972. 44p. Dep. NTIS.

Airblast was measured at distances of 2000 to 61,000 ft from a detonation of four million pounds of ammonium nitrate. The charge was horizontally dispersed in three vertical layers. The top layer contained 0.596 million pounds; the second, 160 ft below, contained 2.119 million pounds and was detonated 87 msec after the first; the third, 100 ft below the second, had 1.285 million pounds and was detonated 144 msec after the first. Attempts to reproduce measured ground-shock-induced peak overpressure using results of previous single, row, and array-charge explosions showed best agreement with the equivalent row-charge analogy, which produced 80% of measured values. (auth)

2504 (UCRL-51260) MECHANICAL PROPERTIES OF ROCKS FROM THE SITE OF THE RIO BLANCO GAS STIMULATION EXPERIMENT. Schock, R. N.; Heard, H. C.; Stephens, D. R. (California Univ., Livermore. Lawrence Livermore Lab.). 30 Aug 1972. Contract W-7405-eng-48. 22p. Dep. NTIS.

The pressure-volume relationship, strength, differential stress-strain, and acoustic velocities were studied as a function of pressure for several samples of graywacke sandstone from the emplacement hole at the site of the Rio Blanco gas stimulation experiment. The results of these measurements are intended for use as input parameters in calculational codes which seek to predict the amount and extent of fracturing produced as a result of the detonation of an underground nuclear explosion. At laboratory strain rates ($\sim 10^{-5}$ sec^{-1}) the sandstones from the emplacement well are found to be rather compressible ($K \simeq 120$ kbar at overburden pressures) but have the relatively high shear modulus ($\mu \simeq 100$ kbar) characteristic of other similar graywacke sandstones. As with these other sandstones, the simulated plane shock-loading path shows pronounced departure away from the failure envelope. Some of this departure may be the result of strain-rate dependent processes. Failure in uniaxial compression is characterized by brittle fracture at mean pressures below 5 kbar and by macroscopic ductile flow above this pressure. Strength properties and the brittle to ductile transition are midway between those found for similar rock-types from the Gasbuggy and Wagon Wheel gas stimulation experiments. (auth)

2505 (UCRL-51261) COMPARISON OF THE MECHANICAL PROPERTIES OF GRAYWACKE SANDSTONES FROM SEVERAL GAS STIMULATION SITES. Schock, R. N.; Heard, H. C.; Stephens, D. R. (California Univ., Livermore. Lawrence Livermore Lab.). 7 Sep 1972. Contract W-7405-eng-48. 25p. Dep. NTIS.

The mechanical properties of seven graywacke sandstones from the locations of four nuclear gas stimulation experiment sites are compared. Data included are pressure-volume measurements to 40 kbar, failure envelopes to mean pressures in excess of 10 kbar, and uniaxial strain loading paths to axial stresses greater than 12 kbar. The results indicate that the total porosity determines the loading path at moderate to high pressure (> 3 kbar mean pressure) and influences the shear strength. However, at low pressure, the loading path seems to be controlled predominantly by the amount and degree of cement which binds the clastic grains. Even at maximum pressure, appreciable porosity remains. With increasing mean pressure all of the rocks exhibit a transition in failure mechanism from brittle fracture to macroscopic ductile flow. On uniaxial strain loading, all show loading away from the failure envelope to the highest mean pressure. (auth)

2506 (USGS-474-149) MASSACHUSETTS MOUNTAIN EARTHQUAKE OF 5 AUGUST 1971 AND ITS AFTERSHOCKS, NEVADA TEST SITE. Fischer, F. G.; Papanek, P. J.; Hamilton, R. M. (National Center for Earthquake Research, Menlo Park, Calif.). Oct 1972. Contract AT(29-2)-474. 20p. (NTS-238). Dep. NTIS.

On 5 August 1971 a locally felt earthquake of magnitude 3.5 occurred on the Nevada Test Site between Yucca and Frenchman Flats at a depth of 4.6 km. The fault-plane solution indicates predominantly strike-slip movement, either dextral on a plane striking N. 22°W. or sinistral on one striking N. 68°E. Locations were determined for 17 events in the aftershock sequence which lasted for about a week. Aftershock focal depths ranged from 6.1 to 10.7 km. The distribution and focal mechanisms of 10 of the larger aftershocks that lie in a narrow zone about 10 km long indicate dextral slip along north-trending faults. (auth)

2507 GREAT TEST-BAN DEBATE. York, Herbert F. Sci. Amer.; 227: No. 5, 15-23(Nov 1972).

The potential effects of a test ban on the national security of the parties to the treaty are examined. Arguments and developments associated with antiballistic missiles, weapons effects, pure fusion bombs, bomb improvements, and military surprises are reviewed. It is noted that the limited test ban is a success and that a comprehensive treaty may now be possible. (J.R.D.)

2508 THEORY OF STRESS WAVE RADIATION FROM EXPLOSIONS IN PRESTRESSED MEDIA. Archambeau, C. B. Geophys. J. Roy. Astron. Soc.; 29: No. 3, 329-66(Sep 1972).

Stress wave radiation from underground explosions has been observed to contain an anomalous shear wave contribution which was most likely of tectonic origin. It is stated that the theoretical radiation field to be expected from an explosion in a prestressed medium is given under the assumption that no secondary low symmetry faulting on a large scale occurs and that the total tectonic component of the field is due to stress relaxation around the roughly spherical fracture zone created by the explosive shock wave. Evidence for the occurrence of this simple kind of tectonic source was considered, and it was concluded that this model was appropriate in many, if not most, instances involving underground explosions. Several possible rupture formations models have been treated, and all have shown that the tectonic radiation was of simple quadrupole form, as has been observed. The energy radiated due to stress relaxation was considered in detail, and it was also shown that, in terms of the energy released, a dislocation source can be used as an equivalent for the stress relaxation effects. The theory can be applied to obtain estimates of source dimensions and the orientation and magnitude of the initial prestress field in the region of the explosion. In addition, application of this particular form of the tectonic source theory to deep earthquakes and volcanic earthquakes also appears to be reasonable in view of the probable high symmetry of the failure or phase transition regions for such events. (auth)

2509 METHOD AND EQUIPMENT USED TO MEASURE THE POWER OF AN AERIAL NUCLEAR EXPLOSION. Casejuane, R.; Dumontet, M.; Rocard, Y. (to Commissariat a l'Energie Atomique). French Patent 2,109,291. 26 May 1972. Filed 9 Oct 1970. (In French).

A procedure for measuring the yield of an atmospheric nuclear explosion is described. The light intensity curve is measured as a function of time. The curve obtained is used to determine the constants t_1 and $t_{(n)}$ which correspond to equal light intensities measured from the instant at which the light intensity variations begin to occur, the ratio n between these time intervals being fixed in advance. (France)

Protective Structures and Equipment

Refer also to abstract 4817.

2510 (ORNL-TM-3911) DESCRIPTION AND SAFETY ANALYSIS OF PHYSICAL EXAMINATION HOT CELLS BUILDING 3025. King, E. M.; Walls, A. A. (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 60p. Dep. NTIS.

A description of the Physical Examination Hot Cells located in the east end of Building 3025 is presented along with safety considerations of the radioactive materials handled and operations performed there. The facility is housed in a two-story brick building. The cell structure consists of six shielded cells arranged in a straight line and located on the second level. The cell walls are shielded with 3 ft of high-density concrete and equivalent $ZnBr_2$ viewing windows and have interiors of stainless steel or painted concrete. The cells are provided with master-slave manipulators, magnifying and photographic periscopes, and either an in-cell crane or a GM manipulator; services (power, water, instrument lines, and hot drains) are provided. Supporting facilities include a carrier storage pad located north of, and adjacent to, the building; a storage facility for radioactive materials under the pad; a canal for underwater transfer and interim storage of radioactive materials; and a laboratory with shielded hoods and a glove box for handling very low-radiation-level materials. The loading area has a bridge crane for cask handling. (J.R.D.)

2511 REMOVAL EFFICIENCY OF ACTIVATED CHARCOAL FILTER IN THE VENTILATION SYSTEM OF A LARGE-SCALE ^{131}I PRODUCTION FACILITY. Izumo, M.; Iguchi, A.; Yamaguchi, I.; (and others) (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 14: No. 10, 540-6(Oct 1972). (In Japanese).

An air-cleaning system embodying activated charcoal filters was constructed for a large-scale ^{131}I production facility at the Japan Atomic Energy Research Institute, for the purpose of removing ^{131}I released continuously into the exhaust air stream from the production facility. The system was continuously operated for about 47 months, and changes in the removal efficiency of the ^{131}I filter for the exhaust air stream was observed during this period. In one run of ^{131}I production, the removal efficiency changed significantly, possibly due to a change in the chemical form of ^{131}I released, accompanying the progress of the ^{131}I production process. When operated at the maximum air flow rate of the filter, it showed an efficiency greater than 90% on the average over a period of 20 months. (auth)

2512 RADIOPROTECTION HELMET. Menetrier, J. (to Appareils Gamma Siar). French Patent 2,105,621. 28 Apr 1972. Filed 15 Sep 1970. (In French).

This radioprotection helmet is constructed (at least partially) of material transparent to radiation of energy in excess of 60 KeV. It is provided with means for accommodating detection instruments around the head of the wearer. Such instruments include a dosimeter as well as a Geiger–Müller alarm dose rate meter. (France)

2513 COLLECTING SYSTEM FOR PARTICULATE MATTER. PERFORMANCE OF PREFILTERS. Kawamura, H. (Oshitari Lab., Inc., Tokyo). Kuki Seijo; 8: No. 7, 24-8(Mar 1971). (In Japanese).

A general description of prefilters is presented. The prefilters are filters which protect high-efficiency filters. The prefilters can be classified according to type or dust collection efficiency by N.B.S., AFI or DOP. A list of prefilters available in Japan classified according to the dust collection efficiency by DOP is given. The first group is the prefilters for coarse dust, and has efficiency of 10 to 60%. The second group is low-efficiency prefilters, efficiency of which ranges from 60 to 90% by the DOP test. The third group is medium-efficiency prefilters with efficiency of 90 to 99.9% by the DOP test. An outline of dust collecting mechanisms and guidance in the selection of the prefilters for various usages and conditions, including reactor use, are presented. (Japan)

2514 CHARCOAL FILTERS FOR CONFINEMENT SYSTEM (8 Jan 1969) (Engineering Materials). (Richland Operations Office (AEC), Wash.). (CAPE-2245).

7 drawings.

Activated charcoal filters, used to remove radioactive I during a reactor accident, are described. The filters may be exposed to high-temperature air, a wet air stream, or both. The filters remove I in the vapor form in the presence of moisture as well as from a dry air stream. The filter features a 1 in. thick pleated-bed which at 1000 scfm air flow and a pressure drop of about 1 in. w.g. will provide 99.99+% ^{131}I removal. (For details see TID-4100 Suppl 72) (F.S.)

Safety Engineering

2515 (ARH-2401) MOBILITY OF PLUTONIUM COMPOUNDS IN SIMULATED FIRE SPRINKLER SPRAY. Panesko, J. V. (Atlantic Richfield Hanford Co., Richland, Wash.). Oct 1972. Contract AT(45-1)-2130. 19p. Dep. NTIS.

Water spray formed a protective layer of water over more-dense plutonium compounds. Dry plutonium compounds immediately settled to the bottom of a layer of water. Plutonium nitrate rapidly diffused throughout sump solution. (auth)

ENVIRONMENTAL AND EARTH SCIENCES

Minerals and Ores

Refer also to abstract 4384.

2516 (AAEC(SP)NM–1972-2) URANIUM MINING INDUSTRY REVIEW, 1971/72. South, S. A. (Australian Atomic Energy Commission, Coogee). Sep 1972. 24p. Dep. NTIS (U. S. Sales Only).

The current status of the Australian uranium mining industry as of June 30, 1972 is reviewed. International developments occurring in 1971 and the first half of 1972 are also covered. Exploration in Queensland, the Northern Territory, South Australia and Western Australia by the companies Mary Kathleen Uranium Ltd., Queensland Mines Ltd., Peko Mines NL/E.2 Industries; Noranda Australia Ltd., Parcontinental Mining Ltd., Petromin NL, Sedimentary Uranium NL and Western Mining Corp. Ltd., is outlined. (Australia)

2517 AGE OF URANIUM MINERALIZATION IN NORTHERN AUSTRALIA. Hills, J. H. (Macquarie Univ., North Ryde, Australia); Richards, J. R. Search; 3: No. 10, 382-5(Oct 1972).

Isotope dating of thirteen pitchblende samples from vein-type uranium deposits in northern Australia is reported (12 from Westmoreland area and one from the Koongarra deposit in the Alligator River belt). Host rocks differ from deposit to deposit and all show effects of wall-rock alteration. Occurrences in both areas indicate emplacement during the same period of regional mineralization in the Late Precambrian. (Australia)

2518 MICROSCOPIC OBSERVATIONS ON THE EFFECT OF MIGRATION OF RADIOACTIVE PARTICLES IN MINERALS. Mitra, S. (Jadavpur Univ., Calcutta). Naturwissenschaften; 59: No. 8, 361-2(Aug 1972).

Radioactive tracks observed in heavy mineral samples, chromites and pitchblends from the Indus River in Pakistan are described. (L.C.L.)

2519 U–Th–Pb SYSTEMATICS AND THE AGE OF THE ONVERWACHT SERIES, SOUTH AFRICA. Sinha, A. K. (Carnegie Inst. of Washington, D. C.). Earth Planet. Sci. Lett.; 16: No. 2, 219-27(Oct 1972).

Five whole rocks from the Onverwacht Series give an age of 3230 to 3290 my by common lead and concordia interpretations. The rocks do not indicate any isotopic homogenization for the U–Th–Pb systems, other than severe loss of uranium and possibly thorium at recent times. A new graphical solution for evaluating U/Pb, Th/Pb, and Th/U ratios in rocks is described, and a preliminary framework model for understanding variations in concentration of Pb through time in basic volcanic rocks is suggested. (auth)

Radioactive Effluents

Refer also to abstracts 4508, 4577, 4624, 4632, 4643, 4667, 4672, 4680, and 4706.

2520 (ARH-SA–140) TEST EXPERIENCE WITH A COMMERCIAL NO_X DESTRUCTOR. Benedict, G. E.; Kiel, G. R.; Raab, G. J. (Atlantic Richfield Hanford Co., Richland, Wash.). 6 Oct 1972. Contract AT(45-1)-2130. 14p. (CONF-721030-2). Dep. NTIS.

From Conference on pollution control and abatement at AEC facilities; Oak Ridge, TN. (25 Oct 1972).

A commercial propane-fired NO_X thermal reducing system was installed on a UO_3 calciner off-gas vent at Hanford. This installation was provided to test the feasibility of using a scaled-up unit to treat the Purex dissolver off-gas. The unit was tested as received and was later modified to get better flame and waste gas mixing. The system's best performance was 300 ppM NO_X in stack gas using a ratio of fuel to air of 1.5 times stoichiometric. The system decolorized the stack emission at approximately 1400°F with excess air and almost no elimination of NO_x. (auth)

2521 (ORP/SID–72-4, pp 1-14) MAN AND HIS ENVIRONMENTAL RESPONSIBILITIES. Lieberman, J. A. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

The need in the U.S. for achieving a quality environment while enjoying a high level of material progress is described. The environmental effects of nuclear facilities and the activities of the Environmental Protection Agency in establishing environmental radiation standards and in judging the environmental impact of such facilities are described. (L.C.L.)

2522 DISPOSAL OF RADIOACTIVITY INTO A CITY SEWERAGE SYSTEM. Blake, K. C. H.; Rapley, L. F. (Groote Schuur Hospital Observatory, Cape Town). Health Phys.; 23: No. 6, 861-2(Dec 1972).

A bolus of about 10 mCi of ^{113m}In was released into a hospital sewer which normally carried inactive waste and urine from patients, undergoing ^{131}I therapy, at a rate of between 150,000 and 200,000 gal/hr. The resultant trace obtained at a continuous monitoring station situated at the local sewage works is shown and indicates a distinct peak commencing $2\frac{1}{4}$ hr after release of the bolus, lasting about 8 min and with an average concentration of 10^{-4} μCi/ml. (UK)

Radioactivity Monitoring and Transport

Refer also to abstracts 2470, 2543, 2563, 2851, 4698, and 4731.

2523 (BNWL–1683) ENVIRONMENTAL SURVEILLANCE AT HANFORD FOR CY-1971. Bramson, P. E.; Corley, J. P. (Battelle Pacific Northwest Labs., Richland, Wash.). Aug 1972. Contract AT(45-1)-1830. 67p. Dep. NTIS.

The 1971 Hanford Environmental Surveillance Program showed continued compliance of the Hanford contractors and their operations with applicable environmental standards. The shutdown of the last of the single-pass cooled production reactors (KE) in January, 1971, eliminated the major remaining source of radioactivity released off-site and of population exposure from Hanford operations. No unusual releases occurred causing Concentration Guides, as given in AEC Manual Chapter 0524, Appendix, Table II, to be exceeded. All measurements of radioactivity outside the plant boundaries were less than 15% of the applicable Concentration Guides. Radiation dose estimates for population groups in the plant environs for 1971 were all less than 1% of applicable standards for plant operations. Off-site measurements of other air and water quality parameters were also well within applicable criteria and showed no significant evidence of plant operations. (auth)

2524 (BNWL–1683(Add.)) ENVIRONMENTAL SURVEILLANCE AT HANFORD FOR CY-1971 DATA. Bramson, P. E.; Corley, J. P. (Battelle Pacific Northwest Labs., Richland, Wash.). Aug 1972. Contract AT(45-1)-1830. 95p. Dep. NTIS.

A compilation of results obtained from both analyses of environmental samples and from radiological measurements made in the Hanford environs during 1971 is reported. The significance of these data is discussed in the parent report (BNWL-1683). Some of the samples analyzed include Columbia River water, drinking water, fish and wild fowl, shellfish, atmosphere, farm produce and commercial foodstuffs, and soil and vegetation. (P.C.H.)

2525 (MLM–1973) ENVIRONMENTAL MONITORING REPORT: JANUARY–JUNE 1972. Carfagno, D. G.; Westendorf, W. H. (Mound Lab., Miamisburg, Ohio). 31 Oct 1972. Contract AT-33-1-Gen-53. 18p. Dep. NTIS.

The environment surrounding Mound Laboratory was monitored and reported on for the first half of 1972. The average concentrations of ^{210}Po, ^{238}Pu, and tritium measured in air and water samples were well within the stringent standards adopted by the Atomic Energy Commission and the Environmental Protection Agency. (auth)

2526 (NRL–F–48) ENVIRONMENTAL RADIOACTIVITY ANNUAL REPORT, 1971. Gregory, L. P. (comp.) (National Radiation Lab., Christchurch (New Zealand)). Jun 1972. 45p. Dep. NTIS.

The results of environmental radioactivity monitoring throughout New Zealand during 1971 are presented. Information is included on: the location of sampling stations; total beta activity in atmosphere and rainwater; total ^{90}Sr deposition; ^{90}Sr content in human bone, milk, and soil; ^{137}Cs content in milk; ^{210}Pb in human bone and rainwater; ^{226}Ra in human bone; ^{89}Sr in rainwater; and ^{238}Pu deposition from weapons testing and from burnup of SNAP device. (L.C.L.)

2527 (ORP/SID-72-4, pp 58-65) REGION IV RADIATION OFFICE ACTIVITIES RELATED TO THE NATIONAL RADIOLOGICAL DATA MANAGEMENT PROJECT. Keefer, D. H. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

Region IV consists of 8 southeastern U.S. states each of whom has been collecting radiation data from environmental monitoring, medical x-ray surveys, and radioactive material inspections for several years. The background and activities of the Region IV Radiological Data Management Program whose purpose is to develop techniques for the preparation and management of these data so that the data can be better utilized by both State and Federal agencies are described. (L.C.L.)

2528 (ORP/SID-72-4, pp 131-60) TERRESTRIAL RADIOLOGICAL MONITORING PROGRAMS AT DUKE POWER COMPANY'S OCONEE AND McGUIRE NUCLEAR STATIONS. Lewis, Lionel. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (2 Apr 1971).

The environmental radioactivity monitoring programs at the Oconee Nuclear Station in South Carolina and the McGuire Nuclear Station in North Carolina are described in detail. Environmental monitoring is subdivided as terrestrial monitoring, i.e., measuring the radioactivity of airborne particulates, rainwater, soils, vegetation, animals, and milk, and aquatic monitoring, which includes monitoring of surface waters, fish, lake bottom sediments, and aquatic vegetation. Information is included on criteria for selection of sampling site, equipment and methods used, expected releases of radioactivity in gaseous and liquid wastes, and comparison of dose estimates with permissible dose levels. (L.C.L.)

2529 WATER, WATER EVERYWHERE, OR ANY DROP TO DRINK... . Ravera, O. (Commission of the European Communities, Ispra, Italy). Euro-Spectra; 11: No. 2, 34-46(Jun 1972).

The very important problem of freshwater pollution is considered in the light of present-day regulations, their efficiency, and limitations being carefully analyzed and weighed. An outline is given of the work of scientific research on freshwater pollution detection and control as it is carried out at the Ispra Establishment of the Joint Research Center. (Euratom)

2530 MEASUREMENTS OF UNCOMBINED RADON DAUGHTERS IN URANIUM MINES. George, A. C.; Hinchliffe, L. (Atomic Energy Commission, New York). Health Phys.; 23: No. 6, 791-803(Dec 1972).

Uncombined fractions of radon daughters were measured in several locations in each of 6 uranium mines with a diffusion-type sampler. Simultaneous measurements were obtained of radon gas concentration, working level and particle concentration. Expressed in accordance with the ICRP definition of uncombined fraction, f, the values obtained ranged from 0.002 to 0.12 with more than half being less than 0.03. The higher fractions were found in fresh ventilating air uncontaminated by diesel engines or dusty operations. An inverse relationship was noted between uncombined fraction and particle concentration, which ranged from $3 \times 10^3 cc^{-1}$ near ventilation inlets to more than $10^7 cc^{-1}$ in main haulageways and working stopes. (auth)

2531 MEASUREMENT OF RADON DAUGHTERS IN AIR. Thomas, J. W. (Atomic Energy Commission, New York). Health Phys.; 23: No. 6, 783-9(Dec 1972).

A simple method for determination of RaA, RaB and RaC has been developed which has a sensitivity of the order of 1 pCi/l for each nuclide. An air sample is obtained and the total alpha disintegrations in three selected time intervals after the end of air sampling determined. The concentration of each nuclide is then obtained from an equation involving the alpha disintegrations, the sampling flow rate, and known numerical coefficients. Simple equations giving the standard deviation of the nuclide concentrations have also been derived. The method was optimized for accuracy by investigating a large number of sampling times and counting intervals, and it is recommended that 5 min air sampling be used, followed by alpha counts from 2 to 5, 6 to 20 and 21 to 30 min after the end of sampling. (auth)

Atmosphere

Refer also to abstract 2829.

2532 (COO-1340-34) ROLE OF THE GENERAL CIRCULATION OF THE ATMOSPHERE IN RADIOACTIVE DEBRIS TRANSPORT. Technical Progress Report, February 1, 1972-January 31, 1973. Reiter, E. R. (Colorado State Univ., Fort Collins. Dept. of Atmospheric Science). Oct 1972. Contract AT(11-1)-1340. 16p. Dep. NTIS.

A brief outline is given of work performed during the contract period Feb. 1, 1972 through Jan. 31, 1973 on the "Critical and Creative Review" of Atmospheric Transport Processes, and on global circulation patterns in both hemispheres. (P.C.H.)

2533 REMOTE SENSING OF ATMOSPHERIC POLLUTION. Sandroni, S. (Commission of the European Communities, Ispra, Italy). Euro-Spectra; 11: No. 2, 56-64(Jun 1972).

A description is given of the most promising techniques for the remote sensing of atmospheric pollution done by monitoring from land or air (spectroscopy, use of lasers and lidar, etc). (Euratom)

Soil

Refer also to abstracts 2836, 2847, 2848, and 2855.

2534 (EUR-4872) CONTAMINATION OF PASTURES BY ^{131}I. PART I. RATE OF DEPOSITION OF ^{131}I. Angeletti, L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1972. 26p. (In French). Dep. NTIS (U. S. Sales Only). EUR FB 40,-.

A reference to the origin and a number of physical properties of iodine-131 and the most important method of studying internal contamination of man is followed by the presentation of various physical and empirical models used for estimating the transfer of radioiodine from the air to the soil. Experimental results are reported relating to the rates of deposit cited in the literature. (auth)

2535 DISEQUILIBRIUM STUDIES IN $^{234}U/^{238}U$ ACTIVITY RATIOS IN COASTAL SEDIMENTS ALONG THE WEST COAST OF INDIA. Joshi, L. U.; Ganguly, A. K. (Bhabha Atomic Research Centre, Trombay, India). Curr. Sci. (India); 41: No. 21, 762-5 (5 Nov 1972).

Sediment samples were collected from the surface of the seabeds at different locations along the west coast of India from monozite areas of Kerala to Bombay. These sediment samples were leached by ammonium carbonate solutions for ^{238}U, ^{235}U, and ^{234}U activities. The reagent was chosen so that it has high efficiency for leaching uranium and does not attack the mineral core of the sediments. Uranium in the leachates was plated on stainless steel planchets and counted using a solid state detector coupled to a 256 channel pulse height analyzer. All the sediment samples were found to give uranium activity ratios, $^{234}U/^{238}U$ within a range of 1.129 to 1.143. The $^{234}U/^{238}U$ activity ratio in coastal waters was 1.151. The $^{235}U/^{238}U$ activity ratios were found to lie in the range of 0.045 to 0.048. Thus, while $^{234}U/^{238}U$ ratio indicates existence of disequilibrium in ^{238}U radioactive series, there is no fractionation between ^{235}U and ^{238}U. (auth)

Water

Refer also to abstracts 2459 and 2844.

2536 (ORP/SID-72-4, pp 161-76) AQUATIC RADIOLOGICAL MONITORING, BROWNS FERRY NUCLEAR PLANT. Stone, G. F. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

The Aquatic Radiological Monitoring Program at the Browns Ferry Nuclear Plant in Alabama is described. Information is included on: the liquid waste processing system; low-level waste disposal into discharge canal; radiochemical analysis of samples of surface waters, fish, plankton, and bottom sediments; methods for checking the quality of the laboratory procedures and analyses; and cost of the monitoring program. (L.C.L.)

2537 (ORP/SID-72-4, pp 177-93) ECOLOGICAL APPROACH TO MARINE RADIOLOGICAL MONITORING AT THE FLORIDA POWER CORPORATION CRYSTAL RIVER NUCLEAR PLANT. Carr, W. E. S.; Englehart, R. W.; Gamble, J. F. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

The marine radiological monitoring program at the Crystal River Nuclear Plant on the northwest coast of Florida was initiated in order to: determine the preoperational levels of radioisotopes existing in the marine environment; assess the food chains which would result in human ingestion of radioisotopes; provide continuous monitoring of the marine environment following plant start-up; and estimate the hazards to man from uptake by marine organisms of waste-discharged radioisotopes. The coastal environment is described. The organisms to be sampled and the sampling methods are presented. The marine food chain to man is illustrated. (L.C.L.)

2538 RELEASE OF EFFLUENTS FROM LIGHT WATER NUCLEAR POWER PLANTS. Candes, P.; Japavaire, R.; Rousseau, L. (CEN de Saclay, Gif-sur-Yvette, France). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 94, 17-25(Mar 1972). (In French).

The different types of containment vessel used in the USA and Europe are described: simple vessel for pressurized water reactors (Fessenheim); double vessel for pressurized water reactor (Obrigheim); simple or double vessel with ice condensers for pressurized water reactors (Sequoyah); depressurized primary vessel with secondary vessel having a controlled leak for boiling water reactors (Zimmer type). The path of gas and liquid effluents in pressurized water and boiling water type reactors is discussed. A numerical analysis of the activity released is given. The quantities of active material released are compared with those permissible. Solutions for minimizing the activity released into the environment are suggested. (France)

Ecosystems and Food Cycles

Refer also to abstracts 2831 and 2834.

2539 (CONF-720708-10) RETENTION OF FALL-OUT CONSTITUENTS IN UPPER LAYERS OF THE PACIFIC OCEAN AS ESTIMATED FROM STUDIES OF A TUNA POPULATION. Hodge, V. F.; Folsom, T. R.; Young, D. R. (Scripps Institution of Oceanography, La Jolla, Calif.). [nd]. Contract AT(04-3)-34. 20p. (SM-158/15). Dep. NTIS.

From Symposium on the interaction of radioactive contaminants with the constituents of the marine environment; Seattle, WA. (10 Jul 1972).

Repeated measurements of ^{60}Co, ^{65}Zn, ^{54}Mn, ^{137}Cs, ^{110m}Ag, ^{108m}Ag, and ^{239}Pu in several organs of albacore tuna suggest that the upper layers of the north Pacific Ocean can retain large fractions of several species of trace elements for periods of a decade or more. For example, ^{137}Cs concentrations in the livers and muscle tissues of north Pacific albacore caught from 1965 to 1971 decreased to half in about 10 years. In comparison, the reported rate of input from fallout during this period decreased more rapidly, closer to half in one year. This suggests a strong retention of ^{137}Cs in the upper water masses which are accessible to the fish. It is of interest to note that long environmental persistences in the upper oceanic layers are also indicated for some other nuclides that are much more highly accumulated by organisms than is cesium. For example, ^{60}Co and ^{108m}Ag concentrations in albacore liver tissues fell to half during this period in 2.6 and 7.1 years respectively. Plutonium-239 concentrations in the livers decreased to half in about 3.5 years. The attenuation rate of ^{65}Zn was discontinuous between 1965 and 1968. This fact, along with observation of comparatively high ratios of ^{65}Zn to ^{60}Co in tunas of the southern hemisphere following 1968, suggests that new large weapons were tested that gave off relatively large amounts of ^{65}Zn. (auth)

2540 (ORP/SID-72-4) PROCEEDINGS OF SOUTHERN CONFERENCE ON ENVIRONMENTAL RADIATION PROTECTION FROM NUCLEAR POWER PLANTS, APRIL 21-22, 1971. (Office of Radiation Programs, Washington, D. C. Surveillance and Inspection Div.). Sep 1972. 240p. (CONF-710461).

Thirteen papers were presented at the conference; a separate abstract was prepared for each paper. (L.C.L.)

For abstracts of individual papers see: 2521, 2527, 2528, 2536, 2537, 2541, 3007, 4447, 4544, and 4696–4699.

2541 (ORP/SID-72-4, pp 29-57) EVALUATION OF ENVIRONMENTAL FACTORS AFFECTING POPULATION EXPOSURE. Honstead, J. F.; Essig, T. H. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

Details are presented on the development of a mathematical model for evaluating the radiation dose received by individuals in the Hanford area population due to radioactivity releases from the nuclear facilities. The particular radioisotope studied was ^{65}Zn, its release to surface waters, migration through the food chain, intake by man, and accumulation in the human body. Data are included on measured ^{65}Zn body burden, ^{65}Zn concentration in drinking water, food intake, and the effects of recreational uses of the Columbia River. The dose calculation computer program is diagrammed. (L.C.L.)

2542 (UCLA-34-P-134-6) BIOLOGICAL CYCLING OF ELEMENTS AND STABLE ISOTOPES IN MARINE ENVIRONMENTS. Progress Report, April 1, 1971–May 1, 1972. Kaplan, I. R. (California Univ., Los Angeles). 1972. Contract AT-(04-3)-34. 208p. Dep. NTIS.

Progress is reported on the following research projects: $^{234}U/^{238}U$ in recent corals, mollusc shells, and calcareous algae from New Caledonia; trace elements uptake by corals and sediment from New Caledonia; distribution of uranium in near-shore marine sediments; a sediment squeezer for removal of pore waters without air contact; and mechanisms for marine iron sulfide formation. (H.L.W.)

Radiometric Techniques

Refer also to abstracts 2350, 2519, 2605, and 2609.

2543 EXPERIMENTAL TECHNIQUE FOR THE DETERMINATION OF THE DISPERSION OF AIRBORNE EFFLUENTS IN A COMPLEX TOPOGRAPHIC ENVIRONMENT. Van As, D.; Short, R.; Van der Westhuizen, M. (Atomic Energy Board, Pretoria). S. Afr. Mining Eng. J.; 20: No. 2, 379-85(1970).

A series of experiments was performed during different meteorological conditions to measure the dispersion of airborne effluents at the site of the South African Atomic Energy Board's nuclear reactor SAFARI 1. The site is surrounded by a complex pattern of hills and valleys. Aerosols of lanthanum and gold were released from a 70 m stack and air samples were collected on filter paper with portable pumps. Lanthanum and gold concentrations were determined by neutron activation of the filter paper samples. Concentrations of 10^{-9} to 10^{-10} g/m^3 could be measured. Results are correlated with meteorological parameters of wind speed, wind direction, and vertical temperature profile and are compared with theoretical dispersion data. Relationships between air concentration and deposited material were determined. (INIS)

2544 PROBE FOR LOCATING SPECIFIC ELEMENTS IN A BOREHOLE. Morgan, I. L.; Rhodes, J. R. (to Nuclear-Chicago Corp.). U. S. Patent 3,697,752. 10 Oct 1972. Filed 1 Apr 1969.

A borehole logging system which is able to identify specific elements by means of x-ray fluorescent analysis is described. The logging probe comprises a pair of symmetrical source and shield assemblies symmetrically mounted between two scintillation detectors. The detector outputs are fed into a field-effect transistor differential count rate circuit. The detectors are equipped with a pair of balanced filters whose K absorption edges fall on either side of an energy band that includes a characteristic radiation energy of the specific element under investigation. (Official Gazette)

2545 DUAL-SPACING NEUTRON LOG: CNL. Alger, R. P.; Locke, S.; Nagel, W. A.; Sherman, H. J. Petrol. Technol.; 24: 1073-83(Sep 1972).

A two-detector neutron tool is described to measure porosity in open and cased boreholes. The dual-spacing neutron log provides improved neutron data when logging conditions include the presence of mud cake, rough borehole walls, and the presence of gas. It also gives better information on the condition of cased holes. The fact that it can be used in combination with other logs makes it possible to obtain multiple logs in one trip, thereby saving rig time. Simultaneous logging also achieves good depth matching, and this facilitates the interpretation. For example, in combination with the density log, it greatly improves the locating of gas; in complex nonshaly formations it provides better indications of porosity and lithology. The combinable dual detection method represents a significant advance in neutron logging. It will lead to further improvement in field and machine-interpreted well log analysis. (auth)

Site Surveys

2546 (USGS-474-152) LITHOLOGIC LOGS AND STRATIGRAPHIC IDENTIFICATION OF EXPLORATORY AND EMPLACEMENT DRILL HOLES IN AREA 7, NEVADA TEST SITE. Sargent, K. A.; Dixon, G. L.; Spengler, R. W. (Geological Survey, Denver, Colo.). Oct 1972. Contract AT(29-2)-474. 71p. Dep. NTIS.

A compilation is presented of lithologic logs of exploratory and emplacement holes in Area 7, Nevada Test Site, with emphasis on identification of Tertiary volcanic units. An index map showing drill-hole locations and contours of the elevation of the Tertiary water level in Area 7 is included. (auth)

Thermal Effluents

Refer also to abstracts 4577, 4578, 4589, 4624, 4632, 4643, 4651, 4667, 4672, 4680, and 4681.

INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstract 3971.

2547 (FRNC-TH-245) ON-LINE ACQUISITION AND TREATMENT OF E.ΔE SPECTRA. Jory, Roger (Paris Univ., Orsay (France)). 1972. 98p. (In French). Dep. NTIS (U. S. Sales Only).

Some of the methods currently employed to identify the products of reactions between heavy ions are described. Methods which utilize E.ΔE telescopes are emphasized. Methods which do not involve using any empirical formulas are proposed. Such methods consider the biparametric spectra (E,ΔE) in terms of topological space. A software package which serves the following functions is described: the on-line acquisition of events, the control of experiments, the separation of ions and the presentation of the results concerning the energy spectra of the different residual nuclei using a digital plotter. (France)

2548 (IPP-9/3) LOW-NOISE CHARGE SENSITIVE PREAMPLIFIER FOR SURFACE BARRIER DETECTORS IN ENERGY ANALYSIS OF LIGHT IONS. Schmidl, Heinz (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Dec 1971. 27p. (In German). Dep. NTIS (U. S. Sales Only).

A preamplifier for silicon surface barrier detectors is described. The FET-input stage is in the form of a printed circuit. It is installed in the vacuum together with the counter and cooled down to 77 K. The resolution, lower limit of detection, zero displacement, and linearity were measured for H^+ and He^+. The best resolution for H^+ is at 1.5 keV fwhm, while the lower limit of detection is at 6 keV. The values for He^+ are slightly higher. (auth)

2549 (KFK-EXT-3/72-7) INVESTIGATION OF THE DETECTION PROPERTIES OF A HYBRID CHAMBER AS A PARTICLE TRACK DETECTOR FOR MINIMAL IONIZING PARTICLES AND AS RADIOISOTOPE CAMERA FOR USE IN NUCLEAR MEDICINE. Boehmer, V. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jul 1972. 40p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Karlsruhe Univ., Ger.

Hybrid chambers are a new type of gas discharge detector sensitive to location. They consist of a two-electrode proportional chamber and a conventional spark chamber in the same gas space. The information about the location of a particle in these detectors can be read out as easily as in spark chambers, while the time resolution is improved by a factor of 5 to 10. This is the first investigation into the influence of mechanical and electrical parameters upon the time resolution, the usable trigger delay and the maximum detection efficiency. Also, recent studies of these detection properties as a function of various filling gases and quenching gas fractions are discussed. Moreover, this is the first demonstration of the possibility to operate hybrid chambers in the self-triggered mode, which also allows low-energy particles to be detected, especially converted gamma quanta. In combination with a lead multiple hole collimator this makes the detector suitable for use as a radioisotope camera for applications in nuclear medicine. The representation characteristics of the camera were studied with a structured Fe-55 source and a test image illuminated by a Tm-170 point source. A rat activated with I-125 is represented. The images of the spark distributions are recorded photographically. In addition, a magnetostrictive readout of coordinates is described which allows simple electronic image recording in combination with a storage oscilloscope. (auth)

2550 (KFKI-72-44) NEUTRON SPIN ECHO: A NEW CONCEPT IN POLARIZED THERMAL NEUTRON TECHNIQUE. Mezei, F. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). Jul 1972. 14p. Dep. NTIS (U. S. Sales Only).

A simple method to change and keep track of neutron beam polarization non-parallel to the magnetic field is described. It makes possible the establishment of a new focusing effect we call neutron spin echo. The technique developed can be applied in several novel ways, e.g., for a neutron spin flipper of superior characteristics, for a very high resolution spectrometer for direct determination of the Fourier transform of the scattering function, for generalized polarization analysis and for new precision range investigation of neutron particle properties. (auth)

2551 (LBL-666, pp 303-58) INSTRUMENTATION AND SYSTEMS DEVELOPMENT. May 1972.

In Nuclear chemistry annual report, 1971.

ATOMIC ABSORPTION SPECTROMETRY — instrumentation for Zeeman effect, p 331

BEVATRON — experimental facility for on-line spectroscopy of reaction recoil products, pp 325-327

— experimental facility for, PDP 8/E computer data acquisition system for, pp 324, 325

— design proposal for acceleration of medium heavy ions using Super HILAC injector and linac booster, pp 315, 316

COULOMETERS — instrumentation for, development of, pp 343-347, 349-350

CYCLOTRONS — development and operation of LBL 88-inch, pp 316, 317

— ion source for LBL 88-inch, development of PIG heavy, pp 318-322

— experimental facility for LBL 88-inch, for spectroscopy of short-lived gases, pp 327-330

GAMMA SPECTROMETERS — calibration of Ge(Li), relative gamma intensity, pp. 357, 358

GERMANIUM — purification for use in high-purity detectors, pp 305-309

INSTRUMENTS — development at LBL, 1971

ION SOURCES — electron cyclotron resonance in Penning, pp 354-356

— description of universal plug-in, for isotope separator, pp 351-353

MASS SPECTROMETERS — description of molecular beam electric deflection, pp 353, 354

MERCURY — determination in Tuna fish, atomic absorption spectroscopy, p 332

RADIATION DETECTORS, PROPORTIONAL — description of multiwire, for particle identifying magnetic spectrometer, pp 322-324

RADIATION DETECTORS, SEMICONDUCTOR (GERMANIUM) — fabrication and performance of high-purity, pp 305-311

— radiation damage to Ge(Li), neutrons

X-RAY FLUORESCENCE ANALYSIS — instrumentation for, development of, pp 333-343 (W.H.K.)

2552 (UCB-34-P-189-X-3) ASTROPHYSICAL AND SUPERHEAVY ELEMENT STUDIES WITH NUCLEAR TRACKS IN SOLIDS. Progress Report, September 1, 1971–August 31, 1972. Price, P. B. (California Univ., Berkeley. Dept. of Physics). 13 Aug 1972. Contract AT(04-3)-34. 6p. Dep. NTIS.

Work is reported in the following areas: nuclear reactions with relativistic heavy ions at the Bevatron, high-Z cosmic rays, heavy particles emitted in solar flares, particle-identification techniques, and theoretical astrophysics. The results of the work have been presented at conferences and submitted to appropriate journals. (R.W.R.)

2553 (UVVVR-2) NEW $4\pi\beta$-MULTIWIRE PROPORTIONAL COUNTER FOR THE 4π $\beta-\gamma$ COINCIDENCE MEASUREMENT. Plch, J.; Zderadicka, J.; Kokta, L. (Institute for Research, Production and Uses of Radioisotopes, Prague (Czechoslovakia)). 1972. 66p. Dep. NTIS (U. S. Sales Only).

The error of the correction for the accidental coincidences contributes considerably to the total precision of 4π $\beta-\gamma$ coincidence counting. An essential decrease of the error can be achieved when the collection time of the primary electrons is reduced when a low multiwire proportional counter is used. The lowest height of the counter was estimated on the basis of calculation of the ion-number distribution for the ions collected on the cathode when hard beta-particles are detected. The height cannot be considerably reduced below 10 mm. A $4\pi\beta$-multiwire counter with the dimensions of $60 \times 60 \times 10$ mm of the counting volume in one half and with 11 wires of 20 μm was developed. The counter filled with technical-grade methane exhibits good timing properties; the FWHM of the time spectrum was 18 nsec. and the full width was 100 nsec. when new fast integrated electronics was used. A fast RC-shaping enables to apply a short dead time of about 2 μsec. in the beta-channel. A good counting plateau, of about 400 V with the slope less than 0.2%/100 V for ^{60}Co and less than 0.1%/100 V for ^{90}Sr, was measured even at high counting rates. (auth)

2554 MEASUREMENT OF SHORT-LIVED NUCLEAR STATES BY METHODS BASED ON THE DOPPLER EFFECT. Kiss, Arpad. ATOMKI (At. Kut. Intez.) Kozlem.; 13: No. 3, 121-36(Nov 1971). (In Hungarian).

The methods used to measure the lifetime of nuclear states depend on the length of the lifetime and the energy emitted during the decay. Since the availability of Ge(Li) detectors, techniques based on the Doppler effect have been widely used. The Doppler shift may be measured by means of the recoil distance (RD) method or by the Doppler shift alternation (DSA) technique. The RD method requires the availability of a reaction which allows to determine precisely the velocity distribution of the recoiled nuclei, whereby the lifetime should be sufficiently long to complete the flight path without decay. The method also requires thin, plane targets. When the DSA technique is used, the charged particles are detected by means of a 180° ring detector. Because of the finite dimensions of the detector and the target chamber, the shift can be detected only within the 30° to 150° interval. The chief shortcoming of the technique is that the γ rays emitted under two angles cannot be measured simultaneously with the same Ge(Li) detector. The average lifetimes which may be measured by the RD method range from 10^{-9} to 10^{-12} sec, bridging the interval between the coincidence and the DSA techniques. The latter may be used for τ values between 10^{-9} and 10^{-15} sec, yielding data with an error of 10 to 25%. (TTT)

2555 RAPID DETERMINATION OF BALANCE POINT IN MULTICHANNEL LIQUID SCINTILLATION COUNTERS. Neame, K. D.; Homewood, C. A. (Univ. of Liverpool). Anal. Biochem.; 49: No. 2, 511-16(Oct 1972).

A method is described for the rapid determination of balance point (photomultiplier gain setting for maximum counts) in multichannel liquid scintillation counters. The random element associated with the rate of radioactivity decay is eliminated by calculating the ratio of the counts in the analyzing channel whose balance point is required to the counts in a second channel, which is set to count all the scintillations detectable by the instrument. If the instrument is set to stop at a preset number of counts in the second channel, balance point may be obtained as accurately from counts in the one channel only. (auth)

2556 POISSON DISTRIBUTION IN NUCLEAR RADIATION MEASURING. Andresen, E. G. (Technische Fachhochschule, Berlin). Kerntechnik; 14: No. 8, 360-6(Aug 1972). (In German and English).

The counting of radioactive decay events always results in a statistically pure series (Poisson distribution) provided it is not vitiated by instrument faults or by biasing measuring procedures. The effects of scalers, the dead time of the measuring arrangement, the background level, and a drift of the measured values on a statistically pure pulse train are studied. (W.H.K.)

2557 MEASUREMENT OF THE RATIO OF THE PROMPT TO THE DELAYED NEUTRONIC RESPONSE OF A SELF-POWERED VANADIUM DETECTOR BY CROSS-CORRELATION TECHNIQUES. Seifritz, W. (OECD Halden Reactor Project, Norway). Nucl. Sci. Eng.; 49: No. 3, 358-69(Nov 1972).

A theory for determining the ratio of the prompt to the delayed neutronic response, W_p/W_d, of a self-powered vanadium detector using methods of stochastic processes is described. Experimental data are also presented. The technique makes use of the inherent reactor noise; it is based upon cross correlating the fluctuating detector current signals from the actual vanadium detector and from a (purely prompt responding) cobalt self-powered detector, both of which are located in a power reactor close to each other. Both the analysis in the time domain and in the frequency domain were used to extract the ratio W_p/W_d. The measurements were performed at the Halden Boiling Water Reactor at 7 MW(th) and the ratio W_p/W_d of a commercial vanadium detector has been determined to be (6.5 ± 0.35)%. The technique described offers several advantages over the commonly used transient measuring method. (auth)

2558 CALIBRATION OF RADIATION MONITORING INSTRUMENTS. Morishima, Hiroshige; Kaga, Taeko; Honda, Yoshihide (Kinki Univ., Osaka). Kinki Daigaku Genshiryoku Kenkyusho Nenpo; 8: 23-8(1970). (In Japanese).

In the Nuclear Research Laboratory of Kinki University, a number of survey meters, a hand-foot-cloth monitor and other monitors are used for radiation monitoring. Since most of these are of the counting-rate indication type, it is required to convert these readings to dose-rate or surface contamination density. In order to perform the measurement, the instruments are calibrated by using or fabricating reference sources. The reference sources were 21 mCi of ^{60}Co and 25 mCi of ^{137}Cs. The results are shown as each calibration curve for the hand-foot-cloth cloth monitor, a gas-flow type α-ray surface contamination monitor, survey meters, area monitors and a water monitor. These monitoring instruments are checked and repaired in the laboratory once a month, and calibrated once a year. (Japan)

2559 PULSE SHAPE DISCRIMINATION APPLIED TO NUCLEAR RADIATION MEASUREMENT. Tsukuda, Masahiro; Murakami, Hiroyuki (Rikkyo Univ., Tokyo). Radioisotopes (Tokyo); 21: No. 3, 186-92(Mar 1972). (In Japanese).

Recently the fine division and complexity of research objects in radiation measurements have been conspicuous, and identification of radiation types in mixed radiation or information on the impact location of incident particles has been required. To accomplish this purpose, a pulse shape discrimination technique has been developed to obtain the useful information by analyzing the pulse shape itself. Initial particle discrimination, measurements in lower energy regions by eliminating background noise, reduction of externally induced noise, and the combination of these with position-sensitive detectors have been accomplished. In the particle discrimination, n−γ, n−γ−p, and γ−p discrimination have been practiced with scintillation counters, for which space charge limitation, zero crossover detection, and analog calculation of pulse height have been considered; and n−γ and p−^{3}He discrimination have been carried out with proportional counters. Applications of these techniques to measurements with semiconductor detectors have also been performed. (Japan)

2560 PROGRESS IN SOLID STATE TRACK DETECTORS. Doke, Tadayoshi (Tokyo Univ.). Radioisotopes (Tokyo); 21: No. 2, 121-37(Feb 1972). (In Japanese).

Progress in solid state track detectors is described. The ion explosion theory and the electron thermal spike theory are in opposition to each other concerning track forming mechanism in the solid state detectors and neither theory is suitable for the mechanism in organic materials. The proposal of Benton and Nix to consider restricted energy loss (REL) as a criterion to decide the existence of formed tracks seems to be more universal. Since the mechanism of track formation by recoil nuclides accompanying α decay is entirely different, elucidation of formation conditions is required. Recently a new type of detector (glass chamber) using a mixed system of two kinds of liquid phase glass has been developed. Scanning techniques for large area detectors are also being developed, which are employed to improve statistical accuracy. Lately, the detectors have been widely utilized for the discrimination of nuclides, and application to research on cosmic rays and atomic nuclides is described. (Japan)

2561 LUMINESCENT INTENSIMETER OF X RADIATION. Sodomka, L. (Coll. of Mechanical and Textile Engineering, Liberec, Czech.). Jemna Mech. Opt.; 16: No. 2, 46-8(Feb 1971). (In Czech).

A method is described of measuring X-radiation, based on luminescence. A luminescent intensimeter (LI) was built making use of copper and manganese activated zinc sulphide and various zinc sulphides used as cathode-phosphors. A detailed description of the design is given together with the measured characteristics. The LI was used for measuring the absorption of X- and gamma-radiation by certain substances. Results of measurements on copper and aluminum foils, cover glass, and quartz are shown in graphs. Stability of the LI was verified by comparison with a MULLARD MX 122 Geiger−Mueller counter. (12 figures) (NSA of Czech.)

2562 EVALUATION OF DIELECTRIC TRACK DETECTORS WITH DIFFRACTED LASER LIGHT. Platzer, H. (Technische Univ., Munich); Abmayr, W.; Paretzke, H. G. Atomkernenergie; 20: No. 2, 162(Feb 1972).

A method for readout of dielectric track detectors based on the Fourier transform analysis of laser light diffraction patterns is discussed. The experimental setup is briefly described. (W.H.K.)

2563 APPARATUS FOR STUDIES OF CONCENTRATIONS OF RADIOACTIVE AEROSOLS PRODUCED AT THE FIRM TESLA N. P. VUPJT, PREMYSLENI NEAR PRAGUE. Dvorak, Viktor (Tesla, Premysleni, Czech.). Prac. Lek.; 24: No. 6, 218-21(Jul 1972). (In Czech).

The technical parameters of two devices for determining the concentration of radioactive aerosols are described. One device is a sampler, NRG 621, which collects aerosol samples the activity of which can be measured by standard radiation detectors. The second device, NXZ 612, permits continuous measurement of the alpha and beta activities in aerosols at the laboratories. (auth)

2564 DEVICE FOR MEASURING THE SHAPE OF A CHARGED PARTICLE BEAM. Sinaev, A. N.; Vishnyakov, V. V. (to Joint Inst. for Nuclear Research). Russian Patent 271,668. 26 May 1970. Filed 29 Dec 1968. (In Russian).

The device consists of a wire spark chamber and a multichannel analyzer. Measurement efficiency is increased by connecting each set of electrodes in the spark chamber to its own recording devices. (R.W.R.)

2565 NITRILES AS SCINTILLATION SOLVENTS AND SOLUTES. Castrillon, J. P. A. (to United States Atomic Energy Commission). U. S. Patent 3,671,455. 20 Jun 1972. Filed 6 May 1971.

Benzonitrile is shown to be an efficient scintillation solvent. Although somewhat inferior to toluene, it can surpass the performance of this standard solvent if quenchers are present. Furthermore, its high dielectric constant, dipole moment, and complexing ability make it suitable for the counting of polar and metallic compounds. It has the interesting property of showing an appreciable light yield in the pure state; thus, α emitters can be counted with no fluors added. Acetonitrile, on the other hand, is a very poor scintillation solvent, although it improves considerably on addition of naphthalene. Also, in a 40% mixture with benzonitrile, the efficiency is good enough for most purposes. In was determined that other aromatic nitriles are also efficient scintillation solvents: p-tolunitrile, 2,3- and 2,4-dimethylbenzonitrile, and phenylacetonitrile, for example. Certain aromatic nitriles are shown to be fairly satisfactory scintillation solutes. (8 figures, 2 tables) (auth)

2566 PERSONNEL PLUTONIUM MONITOR. Hardy, R. W.; Knowlen, R. B.; Sandifer, C. W.; Plake, W. C. (to United States Atomic Energy Commission). U. S. Patent 3,670,164. 13 Jun 1972. Filed 18 Aug 1970.

A system for monitoring a zone for the presence of a source of plutonium is described in which the updated background level of gamma rays is compared with the readings obtained when a possible carrier of a gamma-ray source enters the zone. Counting is initiated, and an alarm is sounded when the counting after a predetermined period of time accumulates to a value in excess of the background total plus a significant statistical deviation as a factor of the background total. (2 figures) (auth)

2567 LOW ENERGY SUPERCONDUCTING PARTICLE COUNTER. Kleppner, Daniel (to Massachusetts Inst. of Tech.). U. S. Patent 3,691,381. 12 Sep 1972. Filed 19 Mar 1970.

Apparatus having a superconductive thin film triggered by an energy pulse detects and counts the incidence of radiant energy upon the film. The film or a portion of the film is driven normal by means of a regenerative process initiated by the temperature rise caused by the energy pulse. A sensing circuit detects the presence of the energy pulse, and then resets the film to its superconductive state. (auth)

2568 PULSE HEIGHT ANALYZER WITH DIGITAL READOUT. Goldsworthy, W. W. (to United States Atomic Energy Commission). U. S. Patent 3,688,305. 29 Aug 1972. Filed 18 Nov 1970.

A feedback-controlled pulse-amplitude integrator and amplifier used as an analog-to-digital converter that converts event-liberated charges emanating from a nuclear-particle detector directly to numbers rather than to analog-dependent voltages is described. (auth)

2569 RADIATION IMAGING APPARATUS. Muehllehner, Gerd (to Nuclear-Chicago Corp.). U. S. Patent 3,683,185. 8 Aug 1972. Filed 8 Aug 1969.

An image intensifier type of gamma ray scintillation camera employing a relatively thick scintillation crystal at the input end for good efficiency in converting gamma rays into scintillations and a fast, position sensitive photodiode with computer circuitry at the output end for producing coordinate electrical signals representing the centroid of the relatively large light spot striking the photodiode is described. Pulse height analysis is performed on the total sum signal from the photodiode to reject unwanted events manifested at the output of the photodiode, and appropriate ratio computing circuitry is employed to maintain a constant image size over a range of intensities of light spots striking the photodiode. (auth)

2570 RADIOCAPSULE FOR REGISTERING IONIZING RADIATION IN THE CAVITIES OF HUMAN BODIES. Pluzhnikov, V. M.; Kalantarov, K. D.; Gugnin, J. Y.; (and others). U. S. Patent 3,690,309. 12 Sep 1972. Filed 5 Aug 1970.

A radiocapsule for registration of ionizing radiation in the cavities of the human body is described comprising a detector to register ionizing particles in the cavities of the human body and to modulate r.f. signals of an inverter of a d.c. voltage into an a.c. sine voltage at the moment when ionizing particles are being registered. The inverter uses a piezo-electric transformer. (auth)

2571 SELECTIVE NEUTRON SENSOR. Martina, E. F. (to Secretary of the Air Force). U. S. Patent 3,688,118. 29 Aug 1972. Filed 25 Feb 1970.

A selective neutron sensor apparatus for selectively detecting a burst of neutrons in a space ionizing radiation environment containing various energetic charged particles utilizing two substantially similar detectors is described. One of the detectors is sensitive to both charged particles and neutrons while the other is sensitive to charged particles only. A differencing circuit receiving the outputs from the two detectors provides an output which represents the true neutron count. (auth)

2572 DATA PROCESSING SYSTEM EMPLOYING QUENCH SIMULATION FOR ENABLING ACCURATE COMPUTATION OF SAMPLE ACTIVITY LEVELS IN LIQUID SCINTILLATION SPECTROMETRY. Packard, L. E. (to Packard Instrument Co., Inc.). U. S. Patent 3,688,120. 29 Aug 1972. Filed 14 Apr 1967.

A data processing system for scintillation spectrometers of the type for measuring activity levels of samples containing radioactive isotopes and subjected to varying degrees of quench is described. Methods and apparatus are described for imposing a controlled simulated quench condition in each sample which, when added to the actual internal quench condition of the sample, creates an effective quench condition equal to a known predetermined actual quench condition for which counting efficiency is known with a high degree of accuracy. True activity levels can be accurately computed in decay events per minute without incurring statistical errors inherent in interpolation and extrapolation techniques employed with conventional quench correlation data. Various methods and apparatus are described for creating a controlled simulated quench for each sample, together with an automatic computational system which permits direct display of activity levels in units of decay events per minute. (auth)

2573 n–p JUNCTION IR DETECTORS MADE BY PROTON BOMBARDMENT OF EPITAXIAL PbTe. Logothetis, E. M.; Holloway, H.; Varga, A. J.; Johnson, W. J. (Ford Motor Co., Dearborn, Mich.). Appl. Phys. Lett.; 21: No. 9, 411-13(1 Nov 1972).

Proton bombardment was used to make n-p junction ir detectors from epitaxial PbTe films on BaF_2 substrates. When cooled at 77°K, these detectors are background limited at f/0.8; further reduction of the field of view gives Johnson-noise-limited peak detectivities of 6×10^{11} cm $Hz^{\frac{1}{2}}$ W^{-1} at f/20. The peak quantum efficiencies are 0.40 to 0.47. (auth)

2574 THERMAL STABILITY OF FISSION TRACKS IN THE STANDARD REFERENCE MATERIAL GLASS STANDARD (NATIONAL BUREAU OF STANDARDS). Reimer, G. M.; Wagner, G. A. (Univ. of Pennsylvania, Philadelphia). Radiat. Eff.; 15: No. 3-4, 273-4(Aug 1972).

The series of four NBS Standard Reference Glass samples contain 61 trace elements added to the base melt in differing nominal concentrations. The concentrations of several elements, including uranium, thorium, and boron, are certified in these glasses. After irradiation with thermal neutrons at various dose levels to induce tracks from ^{235}U fission, the samples were divided and annealed at a series of temperatures and times. The track densities were determined using an optical microscope. An equation is presented to express the ratio of post-annealing to pre-annealing track densities: as expected, the density decreases with increasing time and temperature. In addition, a decrease in track diameters was observed. It is concluded that glasses which are used as fission track references should be stored at 20°C as the tracks have a relatively low thermal stability. (UK)

Radiation Dosimeters

Refer also to abstract 2752.

2575 (CONF-721203-2) PROGRESS IN SOLID-STATE FAST NEUTRON PERSONNEL DOSIMETRY. Becker, Klaus (Oak Ridge National Lab., Tenn.). 1972. 20p. Dep. NTIS.

From Symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The poor stability of latent recoil proton tracks in photographic emulsions has frequently been underestimated due to unrealistic testing conditions. Thin polycarbonate foils to be evaluated by automatic spark-counting exhibit no fading for at least three months at 32°C and 95% humidity. As one of several alternatives

to the NTA film, optimized combinations containing ^{237}Np or ^{232}Th and 10 μm polycarbonate foils are described (^{237}Np covers a wide dose range of $\gtrsim 10^{-3}$ to $\lesssim 10$ rad, and neutron energies $\gtrsim 0.6$ MeV). The directional response is given for different neutron energies and detector-phantom distances. Another approach consists of the amplification of recoil nuclei etch pits to facilitate automatic counting. The inherently low fast neutron response of most solid-state detectors can be increased by intimate contact with a hydrogenous material. TSEE detectors based on BeO, for example, which are covered with a hydrogenous radiator, have been used successfully in recent tests of criticality monitoring systems at ORNL. The thin sensitive layer of exoelectron detectors makes this approach especially attractive for intermediate neutron energies. (auth)

2576 (CONF-721203–3) DEVELOPMENTS IN NEUTRON DOSIMETRY FOR RADIATION PROTECTION. Auxier, J. A. (Oak Ridge National Lab., Tenn.). [nd]. 14p. Dep. NTIS.

From Symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

The spectrum of ORNL neutron dosimetry activities including detector development (especially in the area of solid-state devices), the establishment of monitoring systems in accordance with criteria from international commissions and regulatory bodies, development of generalized concepts of radiation protection, an extensive program of calculating and measuring dose distributions in phantoms, and the formulation of national and international studies for the intercomparison of dosimetry systems is discussed. (W.H.K.)

2577 POSSIBILITY OF ESTIMATION OF EXPOSURE TO FAST-NEUTRONS BY DIRECT COUNTING OF ^{32}P IN HAIR. Solnicka, Hana (Inst. of Industrial Hygiene in Uranium Industry, Pribram, Czech.); Tomaskova, Lenka. Jad. Energ.; 18: No. 10, 342-5(Oct 1972). (In Czech).

The possibility of estimation of exposure to fast neutrons using the direct couting of ^{32}P in hair, induced by the reaction $^{32}S(n,p)^{32}P$, was verified. A limit of detection of fast-neutron dose equivalents was estimated as a function of the counting time and the weight of a hair sample. (auth)

2578 INTEGRAL METHODS OF FAST NEUTRON PERSONNEL DOSIMETRY. I. SURVEY OF APPLIED METHODS. Spurny, Frantisek (Czech. Academy of Sciences, Prague). Jad. Energ.; 18: No. 10, 332-41(Oct 1972). (In Czech).

Integral methods suitable to fast neutron personnel dosimetry are reviewed. Presently applied methods are treated in the first part of this paper. Nuclear track emulsions, sets of activation detectors, methods based on solid state track detectors, moderation of fast neutrons and gaseous ionization and semiconductor radiation detectors are discussed. Fundamental dosimetrical characteristics, i.e., energy dependence, dose and dose rate range, gamma sensitivity, fading, and direction dependence are given for each of the methods. (160 references) (tr-auth)

2579 STUDY OF A DIRECTIONAL NEUTRON DOSIMETER. Gonzalez, A. V. Mexico City; Univ. Nacional Autonoma de Mexico (1972). 68p. (In Spanish).

Thesis.

The possibilities of obtaining data on the direction of incident neutron radiation by the use of a $^{6}LiI(Eu)$ detector encased in a moderator material were investigated. Various geometric forms for the moderator were tested. A Bonner-type sphere, which consists of a hole at a distance from one of its radii, add the characteristic of directionality without altering the other properties of the detector. The instrument developed can be used as a directional dosimeter of neutrons. Similar devices can be developed for other types of radiation. (J.S.R.)

2580 APPLICATION OF EXOELECTRON DOSIMETER. Kawanishi, S. (Osaka Univ., Suita, Japan). Genshiryoku Kogyo; 18: No. 6, 39-45(Jun 1972). (In Japanese).

Exoelectron photography using exo-sensitive paper made of $SrSO_4$ with graphite powder (application to medical diagnostics is expected) and the TSEE measurement of lunar rocks are described. (Japan)

2581 CHARACTERISTICS OF GLASS DOSIMETERS AND RECENT IMPROVEMENTS. Yokota, R. (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Genshiryoku Kogyo; 18: No. 4, 38-46(Apr 1972). (In Japanese).

Glass dosimeters are real integration type dosimeters, that have uniform sensitivity over each glass and every lot, are fit for repeated measurement without receiving influence from measuring operation, and are the most accurate of all dosimeters. Sensitivity, predose, linearity, fading, temperature effect and chemical stability are described. The development of glass materials is reported. Also, the problem of holders for applying them to personal monitoring is investigated, and methods of determining both energy and incident direction of radiation with a single dosimeter glass is developed. The cleaning method and reference glasses are mentioned as the required conditions for measurement. (Japan)

2582 THERMOLUMINESCENCE DOSIMETER (TLD). 3. DEVELOPMENT OF TLD READER WITH DIGITAL DISPLAY. Hiraki, Hisao (Matsushita Electric Industrial Co., Ltd., Osaka); Hasegawa, Seiro; Yamamoto, Osamu; Shirakusa, Hiroshi; Kunishige, Hidenori. Nat. Tech. Rep. (Matsushita Elec. Ind. Co., Osaka); 18: No. 2, 181-9(Apr 1972). (In Japanese).

Lately, thermoluminescent dosimetry is being used in practical applications. As a readout instrument for the dosimeter, a thermoluminescence reader has been developed for personnel dosimetry or medical use. For this purpose, it is required that the reader be compact, lightweight, easy to operate, and feature high sensitivity, accuracy, and reliability. The heating method for readout using a hot air stream makes it possible to minimize heating errors that were previously dependent on dosimeter forms. Readout is accomplished by a 10 second integration method. The current integrator with a solid-state electrometer amplifier has a maximum resolution of 10^{-12} coulomb, and the integrated value is digitally displayed in 4-digits. Four ranges are automatically selected. For dosimeters with different sensitivities, direct readings of dosage can be obtained by adjusting the cathode voltage of the photomultiplier. The system calibration is checked by a built-in calibration source. Accuracy, which is measured for a low-level dose using a highly sensitive $CaSO_4$: Tm TL element, is ±10% at 1 mR and ±3% above 10 mR. Linearity is within ±1% of full scale in each range from 1 mR to 200 R. (auth)

2583 DOSIMETER PROPERTIES OF RADIOPHOTOLUMINESCENCE FLUORIDE GLASSES. Kaes, H. H. (Wissenschaftliche Abteliung E.Leitz, GmbH, Wetzlar, Ger.); Becker, M.; Scharmann, A. Atomenergie; 20: No. 2, 151-3(Feb 1972). (In German).

The radiophotoluminescence of fluoride glasses has been investigated with regard to dosimetric properties (sensitivity, predose, energy-dependence, rising time, and fading) as a function of the cation and of the silver content. Measurements show that the dosimeter properties can be widely adapted to the practical requirements. (auth)

2584 REFLECTIVE PROPERTIES OF HUMAN PHANTOM TO Pu–Be NEUTRONS. Gomaa, M. A.; El-Razek, M. A.; El-Shinawy, R. M. K. (Atomic Energy Establishment, Cairo). Atomkernenergie; 20: No. 2, 154-6(Feb 1972).

Personnel neutron dosimeters may respond not only to incident neutrons but also to body reflected neutrons. In the presence of a Pu–Be fast neutron field, fast neutrons may be reflected as thermal, intermediate and fast neutrons. The Pu–Be fast–fast, fast–intermediate (0.4 to 100 eV) and fast thermal neutron albedo's are found to be (5.9 ± 1.9)%, (9.45 ± 2.2)% and (11.8 ± 1.7)% respectively. Experimental results indicate the dependence of the dosimeter response not only on the angle of the incidence but also on the separation distance between the detector and the phantom. (auth)

2585 IONIZATION CHAMBER WITH HIGH SPATIAL RESOLUTION. Rossi, H. H.; Colvett, R. (Columbia Univ., New York). Phys. Med. Biol.; 17: No. 2, 227-31(Mar 1972).

An ionization chamber with a cavity of 0.002 cm^3 and employing internal proportional gas multiplication is described. It was used in the measurement of the distributions of absorbed doses due to neutron and γ-radiation in the vicinity of needles containing ^{252}Cf. The accurately known factors used for inferring absorbed dose rates from measured ionization currents are discussed. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 3286 and 4011.

2586 (CEA-R-4322) NEW MECHANICAL SPECTROMETER FOR THERMAL NEUTRONS: STUDIES, TESTS, AND PRELIMINARY RESULTS. Bugnone, C. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1972. 96p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

A mechanical spectrometer for neutrons between 10^{-4} and 1 eV is presented. The neutrons are detected using neutrography type methods. The apparatus was tested using the neutrography channel of the Siloette pile, which provides a thermal neutron beam or

a beam modified by Bi. The apparatus is rapidly set into operation and can be used for low intensity beams (of the order of 10^5 neutrons/cm^2 s) or for short duration high intensity bursts (10^{10} neutrons/cm^2 s) of neutrons of 1 second duration. (France)

2587 (COO–2231-1) NEUTRON SPECTROMETRY FROM 1 MeV TO 1 GeV. Madey, Richard; Waterman, F. M. (Kent State Univ., Ohio). 1972. 12p. (CONF-721203–4). Dep. NTIS.

From Symposium on neutron monitoring for radiation protection purposes; Vienna, Austria (11 Dec 1972).

A self-contained time-of-flight spectrometer for neutrons in the region from 1 to 500 MeV is described. The spectrometer consists basically of two scintillation counters. The principle of the spectrometer requires an incident neutron to scatter elastically from a proton in the first scintillator, travel over a known flight path, and interact in the second scintillator. The time interval between these scintillation pulses is the time-of-flight of the scattered neutron. Kinematically, the kinetic energy of the incident neutron is specified in terms of the scattering angle, the flight path, and the flight-time of the scattered neutron. A typical spectrometer configuration for neutrons above about 15 MeV consists of a 2½ in. diam. by 2½ in. high first detector and a 9 in. diam. by 8 in. thick second detector spaced 4 m from the first detector and at an angle of 40° with respect to the direction of the incident neutrons. For this configuration, the energy resolution varies from 7 to 20 percent and the spectrometer efficiency varies from 2×10^{-5} to 8×10^{-7} over the range of energies from 10 to 500 MeV. In measurements made thus far, the count rate of real events was typically 1 count/sec. A modified version of the spectrometer has been designed to extend the range of the spectrometer upward to about 1 GeV. In the modified version, a telescope of two scintillation counters detects the recoil proton in coincidence with the scattered neutron. The quadruple coincidence requirement reduces the background from chance coincidences and from competing inelastic reactions of neutrons with carbon and hydrogen in the first scintillator; however, since the recoil proton must escape the first detector, this technique becomes increasingly inefficient below about 200 MeV. (auth)

2588 (IBK–1050) NEUTRON ENERGY SPECTRUM UNFOLDING METHOD. Krcevinac, S. B. (Institut za Nuklearne Nauke Boris Kidric, Belgrade (Yugoslavia)). Oct 1971. 146p. Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Birmingham, Eng.

The unfolding of neutron energy spectra using low-resolution data is investigated, and developments both in techniques and methodology are reported. A theoretical study of the properties of the activation equation has been performed and its close relationship with the Fredholm integral equation is established. It is pointed out that such a problem is mathematically incorrectly posed and does not allow for a direct solution. Thus, the inherent instabilities of the unfolding procedure are explained. The method of regularization, devised for the approximate solution of the operator equations of the first kind, is applied to solution of the activation equation. It is shown that instead of solving the activation equation using direct methods, a solution should be sought by minimizing the so-called additive functional. The choice of the regularizing part of the additive functional has been discussed thoroughly. A use of a simple theoretical model reflecting the basic physics of the problem has been proposed for the construction of the regularizing functional. Various underlying numerical techniques have been examined and associated computer programs have been written. The proposed unfolding method was tested in a series of numerical experiments and real measurements of thermal-neutron spectra in some of the lattices of a heavy water-natural uranium zero power reactor. Several different detector systems were considered in the feasibility study and in real measurements. A use of the filtered foil technique is investigated and the results are reported. The measurements of induced activities are performed using a high-resolution semiconductor gamma-ray spectrometer. The accurate analysis of a large volume of data is accomplished using a computer program. In addition, the unfolding of some literature results obtained using photographic emulsions, proton-recoil proportional counters, Bonner spheres, and threshold detectors has been performed using the proposed methods. (auth)

2589 SECTOR-TYPE DOUBLE FOCUSING BETA-RAY SPECTROMETER. Nakamura, Masamoto (Tokyo Metropolitan Isotope Research Center); Yamamoto, Kakuji; Kikuchi, Bunsei. Proc. Fac. Sci. Tokai Univ.; 6: No. 1-2, 65-76(Mar 1971).

The characteristics of the double focusing beta-ray spectrometer having a reference radius of 15 cm and a deflection angle of 180° designed on the basis of the inhomogeneous sector magnetic field theory are described. Resolution and gathering power of the spectrometer with the ^{137}Cs K-conversion line were 0.52% and 0.3% respectively. Low energy electrons less than 5 keV were measured by using a plastic scintillator of 1.5 mm in thickness as a detector. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 3187 and 3333.

2590 (BNL–16937) REPORT ON THE BROOKHAVEN SOLAR NEUTRINO EXPERIMENT. Davis, R. Jr.; Evans, J. C.; Radeka, V.; Rogers, L. C. (Brookhaven National Lab., Upton, N. Y.). [nd]. 17p. (CONF-720651–1). Dep. NTIS.

From Symposium on neutrino '72; Balatonfured, Hungary (11 Jun 1972).

A solar neutrino experiment has been in progress since 1967 to observe neutrinos from the sun by the neutrino capture reaction $^{37}Cl(\nu,e^-)^{37}Ar$. 380,000 liters of perchloroethylene, C_2Cl_4, are used as a neutrino capturing medium. The radioactive ^{37}Ar (35.1-day half-life) is removed from the liquid by purging with helium gas, purified, and counted in a small low-level proportional counter. Argon-37 decay events are characterized by the energy of the event, and the rise-time of the counter pulse. The results of six experiments performed during the last two years are given. The ^{37}Ar production rate in the detector was 0.18 ± 0.10 per day, close to the production rate expected from cosmic ray muons. The experiment places an upper limit on the production of ^{37}Ar by solar neutrinos of 1×10^{-36} sec^{-1} (^{37}Cl atom)$^{-1}$. This limit can be compared to the currently predicted rate of 9×10^{-36} sec^{-1} (^{37}Cl atom)$^{-1}$ from solar model calculations of Bahcall and Ulrich, and Abraham and Iben. (auth)

2591 (CERN-Trans–72-6) VAPOR BUBBLE DYNAMICS IN HYDROGEN BUBBLE CHAMBERS. Tkachev, L. G.; Shestakov, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Translated by N. M. Harigel and G. Harigel (CERN, Geneva), from report JINR–P13-6037. 24p. Dep. NTIS (U. S. Sales Only).

Theoretical considerations of vapor bubble dynamics in a hydrogen bubble chamber are given. The system of equations takes into account the heat and mass exchange between a bubble and liquid. The vapor in the bubble is described with the real gas equation of state. Computer solutions are in agreement with the corresponding experiment. A set of temperature distributions in the surrounding liquid during the cycle of bubble chamber is presented. The important role of the temperature distribution formed during the bubble growth is shown for the correct description of the bubble collapse. Some predictions are made for the bubble behavior in fast-cycling chambers. The results of numerical calculations for the bubble growth and collapse in the static pressure of the bubble chamber are discussed. The stability of self-similar solutions describing bubble growth is proved. Conditions for self-excitation oscillations in the bubble collapse take place. These natural frequency pulsations lead to the lifetime increasing. In this connection the possibility of the existence of stable bubbles pulsating in the overpressed liquid is considered using both analytical and numerical methods. It is shown that the assumption of the existence of such bubbles leads to a contradiction in the system of equations. (auth)

2592 (CERN-Trans–72-9) SELECTION OF ELECTRONS IN SECONDARY PARTICLE BEAMS OF UP TO 50 GeV/c AND DETECTION OF ELECTRON SHOWERS. Kachanov, V. A.; Kut'in, V. M.; Lapshin, V. G.; Rykalin, V. I.; Semenov, V. K. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). Translated by R. Luther (CERN, Geneva), from report IFVE-SEF–71-89. 18p. Dep. NTIS (U. S. Sales Only).

The application of high-resolution threshold Cherenkov counters for the selection of electron beams up to 50 GeV/c at the Serpukhov Synchrotron is described, and data are given on electron yields as well as the results of some systematic investigations on electron beams. The results of electron energy measurements using lead-scintillation sandwiches are given, as are the transverse dimensions of electron showers in lead using a scintillation hodoscope based on a hodoscopic photomultiplier. (W.H.K.)

2593 (SLAC–150) FIT70: A KINEMATIC FITTING ROUTINE. Park, J. C. H. (Stanford Linear Accelerator Center, Calif.). Jun 1972. Contract AT(04-3)-515. 37p. Dep. NTIS.

FIT70 was used to perform the kinematical analysis of a photoproduction experiment with the streamer chamber at SLAC. The 2-meter streamer chamber with a pressurized hydrogen gas target was exposed to an 18 GeV bremsstrahlung beam. 640,000 pictures (in 3 views) were taken by triggering the chamber for hadronic events. Events were measured using con-

ventional hand-guided machines and were then processed through the geometry program SYBIL. The resulting track parameters were then input to FIT. The purpose of the program is to adjust by minimizing a certain chi^2 the input data consisting of mass and momentum for each track associated with a vertex so that the fitted data satisfy the energy momentum conservation. The method and program are described. FIT70 is in FORTRAN IV for the IBM System 360/91. (W.H.K.)

2594 (UCRL-Trans-10644) NUMERICAL METHOD FOR SOLVING A FUNDAMENTAL PROBLEM IN MAGNETOSTATICS. Doinikov, N. I.; Simakov, A. S. (Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)). Translated for Univ. of California, Lawrence Livermore Lab., Livermore, from Preprint B-0155. 30p. Dep. NTIS.

Methods of numerical solution of spatial boundary problems of magnetostatics (linear and nonlinear) on a computer are described. The methods are based on the finite-difference approximation of the integral form of Maxwell equations with respect to rectangular and irregular nets. A modified scalar potential is considered as the sought function. Its essential advantages in the case of spatial fields are noted. Two iteration schemes are discussed. The developed methods are then illustrated on specific examples including the end field of a bending electromagnet and the field in an electromagnet of a bubble chamber. The results of numerical modeling are compared with those of magnetic measurements. (auth)

2595 FAST CHARGED-PARTICLE DETECTION. Korkhmazyan, N. A.; Elbakyan, S. S. (Erevan State Univ.). Dokl. Akad. Nauk SSSR: 203: No. 4, 791-3(1 Apr 1972). (In Russian).

The possibility of using x rays and harder radiation in undulators for identifying and measuring the energies of ultrafast charged particles is explored. The number of quanta released were calculated for the first 20 harmonics for a given field amplitude (104 oersteds) and period (10 cm). A study was made of the dependence of energy at various frequency intervals on the energy of the particles. (K.S.W.)

2596 FIELD STUDIES FOR THE PROPOSED HIGH FIELD BUBBLE CHAMBER MAGNET. Diserens, N. J.; Trowbridge, C. W. (Rutherford High Energy Lab., Chilton, Eng.). pp 129-41 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

Magnetic field calculations for the proposed Rutherford high field bubble chamber were performed using the computer program TRIM. The bubble chamber will contain a 70 kG superconducting magnet of 1.9 meters internal diameter which will be surrounded by a magnetic screen containing some 10^6 kg of iron. Modifications to TRIM are discussed, and calculation of the magnetic pressure on the iron shield using the fields from TRIM is outlined. The magnetic fields in the coil region were computed to a high degree of accuracy and hence the body forces were derived. These were used to determine the elastic-plastic stresses within the coil assembly. (W.H.K.)

2597 MAGNET OF THE HYDROGEN BUBBLE CHAMBER MIRABELLE. Tsai, N.; Desportes, H.; Duthil, R.; Lesmond, C. (CEN, Saclay, France). pp 617-26 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—description for Mirabelle bubble chamber
RADIATION DETECTORS, BUBBLE CHAMBER—magnet for Mirabelle, description of (W.H.K.)

2598 DESIGN AND FABRICATION OF STEEL CORE FOR THE 12-FOOT HYDROGEN BUBBLE CHAMBER SUPERCONDUCTING MAGNET. Bywater, James A.; Genens, Lyle E. (Argonne National Lab., Ill.). pp 655-68 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—core for ANL 12-ft hydrogen bubble chamber superconducting, design of steel
RADIATION DETECTORS, BUBBLE CHAMBER—magnet for ANL 12-ft hydrogen, design of steel core for superconducting (W.H.K.)

2599 12.6 TESLA-METRE SUPERCONDUCTING BENDING MAGNET. Kesseler, G.; Lazeyras, P.; Schmeissner, F. (CERN, Geneva). pp 768-79 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—description of 12.6 telsa-meter superconducting beam bending, for injection into CERN 12.6-meter bubble chamber
RADIATION DETECTORS, BUBBLE CHAMBER—beam bending magnet for injection into CERN 3.7-meter, 12.6 telsa-meter superconducting (W.H.K.)

2600 TESTING AND OPERATIONAL EXPERIENCE WITH THE 12-FOOT BUBBLE CHAMBER MAGNET. Purcell, John R. (Argonne National Lab., Ill.). pp 869-73 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—description of superconducting, for ANL 12-foot hydrogen bubble chamber
RADIATION DETECTORS, BUBBLE CHAMBER—magnet for ANL 12-foot hydrogen, superconducting (W.H.K.)

2601 BIG EUROPEAN BUBBLE CHAMBER (BEBC) MAGNET PROGRESS REPORT. Haebel, E. U.; Wittgenstein, F. (CERN, Geneva). pp 874-95 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—description for BEBC bubble chamber
RADIATION DETECTORS, BUBBLE CHAMBER—magnet for BEBC, description of (W.H.K.)

2602 HOLLOW CONDUCTOR WITH TWISTED SUPERCONDUCTING FILAMENTS FOR A SPARK CHAMBER MAGNET. Schaetti, N.; Rayroux, J. M.; Meyer, G.; Schiller, A. (Brown, Boveri and Co. Ltd., Zurich). pp 1136-47 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNET COILS—description of hollow superconducting, for spark chamber magnet
RADIATION DETECTORS, SPARK CHAMBER—magnet for, hollow superconducting magnet for (W.H.K.)

2603 PRELIMINARY WORK ON FIELD-FREE PARTICLE BEAM PATHS FROM HOLLOW SUPERCONDUCTING SHIELDING TUBES. Firth, M.; Krempasky, L.; Schmeissner, F. (CERN, Geneva). pp 1178-89 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

RADIATION DETECTORS, BUBBLE CHAMBER—beam injection into, field-free hollow superconducting shielding tubes for low-momentum (W.H.K.)

2604 "MIRABELLE" DC POWER SUPPLY. Lefrere, P.; Legout, J.; Bolant, R. pp 1329-41 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—power supply for Mirabelle bubble chamber, dc
POWER SUPPLIES—description of dc, for Mirabelle bubble chamber magnet
RADIATION DETECTORS, BUBBLE CHAMBER—magnet power supply for Mirabelle, dc (W.H.K.)

Radiometric Instruments

2605 STUDY ON THE SENSITIVITY OF SOIL MOISTURE MEASUREMENTS USING RADIATION TECHNIQUES, NYLON RESISTANCE UNITS, AND A PRECISE LYSIMETER SYSTEM. De Boodt, M.; Verplancke, H.; Laksmipathy, A. V. (State Univ. of Ghent). pp 605-19 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

Weighable lysimeters are by no means the only instruments which can be successfully used to find the evapotranspiration at a given surface. In an attempt to find an accurate and relatively inexpensive method a hydraulic system was developed

involving the use of water-filled flexible rubber bolsters, made of neoprene reinforced with nylon cloth. These bolsters already produced a great improvement in the accuracy and the hysteresis effect was practically nil. Since the changes in weight resulting from changes in moisture content of the soil in the tank are relatively small, a pressure-transducer together with a recorder was used for continuous registration of the weight changes of the lysimeter. The data are easily reproducible with a high accuracy and sensitivity. The device allows the detection of 5×10^{-3} mm water difference. For measuring soil water content a modified neutron scattering moisture probe was used. These devices were tested directly by measuring water content profiles in a 1 $m^2 \times$ 1 m weighable lysimeter after a large number of irrigation cycles, and comparing the calculated depletion amounts with those computed directly from the weight recordings. Because of the increasing interest in the application of resistance methods to large-scale irrigation control an improved nylon resistance unit was constructed by which it is possible to measure the moisture content of the soil almost from saturation to air dryness. The nylon units were buried in the lysimeter and resistance readings were made regularly during the irrigation cycles. Estimations of soil water content as measured by the nylon resistance method and radiation techniques are compared with the data obtained from the weighable lysimeter. (auth)

2606 GAS AND SMOKE DETECTOR. Greverie, F. (to Societe Industrielle d'Electronique et d'Informatique). French Patent 2,105,531. 28 Apr 1972. Filed 10 Sep 1970. (In French).

A system for detecting gas or smoke is presented. It consists of two ionization chambers which are adjacent and mounted in series between the poles of a fixed potential power supply. The two chambers are provided with a single radioactive source. The detector also incorporates an electronic circuit capable of actuating an alarm signal from information received from an electrode which is common to the two chambers. The two chambers of the detector developed have the same size. The radioactive source is positioned laterally using a support outside the two chambers. Its position can be adjusted about a level similar to that of the common wall of the two chambers so that in a normal atmosphere the potential on the electrode remains constant. The system is provided with the necessary electronics. (France)

2607 IONIZATION SMOKE DETECTOR. Kobayashi, Akihiro (to Nittan Co., Ltd.). U. S. Patent 3,688,119. 29 Aug 1972. Priority date 24 Jul 1969, Japan.

An ionization smoke detector having open and closed ionization chambers each having at least two electrodes and a radioactive source is described. The electrodes are connected in series across a voltage supply and the change of impedance of the open ionization chamber is detected by a field effect transistor which in turn fires a silicon controlled rectifier. The silicon controlled rectifier is provided with a holding circuit so that when utilizing a pulsating voltage, the silicon controlled rectifier will be maintained in a conductive state even though the pulsating voltage periodically approaches zero. The invention further contemplates means for controlling the current through the source-drain path of the field effect transistor so that wide voltage fluctuations will not damage the transistor or produce erroneous alarm signals. (auth)

2608 APPARATUS FOR INSPECTING TUBULAR GOODS HAVING AN AUTOMATIC SHUTTER. Hugonin, G. H. (to Schlumberger Tech. Corp.). U. S. Patent 3,684,887. 15 Aug 1972. Filed 26 Mar 1970.

In the new and improved radiation apparatus disclosed herein for inspecting tubular goods, a radiation detector is coaxially positioned within a tubular member being axially translated along a selected inspection axis for receiving radiation from a radiation emitter facing the detector and mounted in a body rotating around the exterior of the tubular member. One or more radiation-attenuating devices or shutters are cooperatively arranged in the rotating body for regulating the intensity of radiation imposed on the detector. Uniquely-arranged controls are provided for selectively positioning the shutters as tubular members that are to be inspected move along the inspection axis, with these controls being adapted for operation without interrupting the rotation of the body carrying the shutters. (auth)

2609 METHOD OF AND SYSTEM FOR INDIRECTLY MONITORING THE OUTPUT OF A PULSED NEUTRON SOURCE. Givens, W. W. (to Mobil Oil Corp.). U. S. Patent 3,688,117. 29 Aug 1972. Filed 18 May 1970.

A borehole tool for assaying for uranium which has a pulsed neutron source of the accelerator type and a detector for detecting delayed fission neutrons is described. In operation, the source is periodically actuated to produce very short neutron bursts having a duration of a few microseconds. Located adjacent the source is a target which emits delayed radiation when irradiated with neutrons from the source. A detector is employed to detect the delayed radiation emitted from the target to obtain an indirect measure of the neutron output produced by the source. (auth)

2610 IMPROVEMENTS IN OR RELATING TO A METHOD AND APPARATUS FOR STORING INFORMATION. Pooley, Derek (to United Kingdom Atomic Energy Authority). British Patent 1,281,991. 19 Jul 1972. Filed 21 Jun 1968.

The method described is based on the irradiation of luminescent phosphors. The phosphor is irradiated with a beam of radiation of energy sufficient to damage it so as to affect its luminescent properties, and then selected regions are irradiated with higher energy radiation from the same source so as to anneal out damage at these regions and restore the phosphor to its undamaged and normal state at these regions, the distribution of annealed and damaged regions being representative of the information to be stored, for subsequent readout. The phosphor may be cathodoluminescent and the radiation may comprise electrons. Reading of stored information is effected by scanning over the phosphor surface with a low-energy pulsed electron beam so as to produce photon pulses incident on a photocathode. The phosphor may be coated onto the screen of a cathode ray tube. (UK)

2611 DEVICE FOR MEASURING THE CROSS-SECTION OF WIRE AND THE LIKE. Knueflemann, Manfred; Seidel, Ingo (to Gesellschaft fuer Nuklearmerstechnik). U. S. Patent 3,684,888. 15 Aug 1972. Filed 20 Apr 1970.

To ascertain the uniformity of the cross-section of a wire or other elongated object, a beam of soft radiation emitted by a radioactive isotope such as ^{241}Am or ^{90}Sr is focused upon the longitudinally moving object as a beam bracketing that object with allowance for dimensional tolerances and minor deviations from straight-line motion. The unabsorbed beam energy beyond the object is intercepted by a detector and gives rise to an output signal varying with changes in the mass of the object per unit length. The signal may be fed back to a rolling mill or other apparatus to compensate for cross-sectional changes of the object continuously issuing therefrom. (auth)

2612 DUAL PURPOSE RADIOACTIVITY WELL LOGGING DETECTOR SYSTEM. Youmans, A. H. (to Dresser Industries, Inc.). U. S. Patent 3,688,114. 29 Aug 1972. Filed 13 Jul 1970.

A well logging system that utilizes a determination of the lifetime of neutrons in the formations surrounding a well bore which includes a dual purpose detector is described. The detector system includes a movable shield positioned to exclude neutron radiation from a CsI crystal. Means are provided to displace the shield and the system is synchronized with a recorder. (auth)

Radiation Effects on Instrument Components, Instruments, or Electronic Systems

Refer also to abstracts 2573, 4331, and 4338.

2613 (CEA-CONF-2083) S.E.M. BEAM INDUCED CURRENT STUDIES IN PLANAR p–n JUNCTIONS. QUANTITATIVE MEASUREMENTS OF MINORITY CARRIER LIFETIMES. EVALUATIONS OF LATERAL DIFFUSION DOPING PROFILES. Bresse, J. F. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 2p. (CONF-720436–2). Dep. NTIS (U. S. Sales Only).

From fifth annual scanning electron microscope symposium; Chicago, IL. (25 Apr 1972).

A physical model to calculate the spatial distribution of the scanning electron microscope beam induced current across different types of p-n junctions is presented. (W.H.K.)

2614 EFFECTS OF NEUTRON RADIATION ON TRANSISTORS. Martinez, L. A. W. Mexico City; Instituto Politecnico Nacional (1972). 147p. (In Spanish).

Thesis.

The effects of neutron radiation on transistors were studied knowing only parameters which appear in the manuals furnished by the fabricators. The values found for the lifetime damage constant proved the validity of the damage model developed. The results obtained in the prediction of the common emitter current factor were satisfactory if experimental errors are considered. (J.S.R.)

2615 APPLICATION OF RADIATION-ENHANCED DIFFUSION TO MICROWAVE TRANSISTOR FABRICATIONS AND ITS

DESIGN OPTIMIZATIONS. Yamamoto, S.; Sakamoto, T.; Zohta, Y.; Mimura, S. (Tokyo Shibaura Electric Co., Kawasaki, Japan). J. Jap. Soc. Appl. Phys., Suppl.; 41: 215-19(1972).

Application of radiation-enhanced diffusion (RED) to microwave transistors, proposed by Abe et al., to improve power gain by reducing collector capacitance without sacrificing other electrical parameters, was investigated in detail from the device design viewpoint with the aid of computers. It was found that about 2 dB increase in U and 1.5 dB improvement in MAG at 4 GHz can be expected when the optimized structure is realized by employing RED compared with conventional transistors. The feasibility of this technology is also demonstrated by describing various processing steps and by experimental data obtained. (auth)

2616 DESIGN AND CONSTRUCTION OF A CONCRETE INSULATED QUADRUPOLE MAGNET. Willis, D. R.; Wilson, D. (Lintott Engineering Ltd., Sussex, Eng.). pp 677-83 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS — design of radiation-resistant concrete insulated quadrupole
— radiation effects on, use of concrete insulation for reducing (W.H.K.)

2617 IMPROVEMENTS IN THE PROPERTIES OF ORGANIC MATERIALS IN ACCELERATOR MAGNETS. Van de Voorde, M. H. (CERN, Geneva). pp 1212-23 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS — radiation resistance of organic components of accelerator (W.H.K.)

2618 HYDRATING CEMENTS FOR RADIATION RESISTANT MAGNET CONSTRUCTIONS. Gresham, A. T.; Sheldon, R.; Stapleton, G. B. (Rutherford High Energy Lab., Chilton, Eng.). pp 1224-33 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

ACCELERATORS — magnets for, radiation resistant mineral electric insulators for
ELECTRIC INSULATORS — radiation resistance of mineral, for accelerator magnets
MAGNETS — insulators for accelerator, radiation-resistant mineral electric (W.H.K.)

Miscellaneous Instruments

Refer also to abstracts 3108, 3109–3111, 3255, 3256, 3297, and 4819.

2619 (CEA-CONF-1899) RECURRENT ANALYZER FOR A FAST TRANSITORY SIGNAL. Imhoff, Claude; Andrieu, Francois; Balanca, Charles (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). 12 Apr 1972. 17p. (In French). (CONF-720452-4). Dep. NTIS (U. S. Sales Only).

From Half-day conference on the treatment of the ultrafast transient signal; Saclay, France (12 Apr 1972).

A device designed for the analysis and memory of a fast transitory signal, unique or of very low recurrence, is described. The digital analog converter furnishing 8 bits in 100 nsec presents on the memory oscilloscope the advantage of storing indefinitely the signal and of being able to restore it for a later processing. The operating principle of the analyzer is given. The component functions of the analyzer—sampling path, logical memory and transcoding circuit, frequency circuits, and principal memory—are described in detail. (J.S.R.)

2620 (CEA-CONF-2023) SUBNANOSECOND ANALYZER OF A VERY BRIEF TRANSITORY SIGNAL. Bernet, M.; Trabaud, M. (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). 12 Apr 1972. 17p. (In French). (CONF-720452-6). Dep. NTIS (U. S. Sales Only).

From Half-day conference on the treatment of the ultrafast transient signal; Saclay, France (12 Apr 1972).

The subnanosecond analyzer ARIES 300 (fast pulse analyzer by sequential sampling) is described. It consists of a numerizer sampling element which connects the capture of the magnitude to be measured to the processer which memorizes and processes the information. The ARIES 300 has three main functions: an amplitude function, a time function, and a multiplex and output logic circuit. The signal distributer, sampling paths, selection of the conversion mode, and the time distributer are described. The precision of the amplitude measurements is 1% + the background and the linearity is 1%. The sampling step can go from 1 to 50 nsec. The time precision of the sampling is 100 psec ± 1%. Possible applications of the analyzer are discussed. (J.S.R.)

2621 (CEA-CONF-2025) MEASUREMENT AND VISUAL DISPLAY OF LUMINOUS SUBNANOSECOND PULSES: USE OF A PICOSCOPE. Eschard, G.; Clement, G.; Delmare, M. C. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). 12 Apr 1972. 12p. (In French). (CONF-720452-3). Dep. NTIS (U. S. Sales Only).

From Half-day conference on the treatment of the ultrafast transient signal; Saclay, France (12 Apr 1972).

A hyperfast photodiode and a photomultiplier with microchannels are described. They both should be associated with an oscilloscope with large pass band. The photodetector element and the scanning device were integrated in one tube, the picoscope. The use of a microchannel disk made it possible to increase the sensitivity of the detector and to augment the time resolution. The picoscope should enable the measurement of variable luminous phenomena with a time precision of 10 psec. Because of the spiral scanning, this same resolution can be preserved during a total observation time of 100 nsec. (J.S.R.)

2622 (EUR-4895) COUPLING CAMAC CRATE CONTROLLERS TYPE "A" TO THE PDP-11 UNIBUS. Stueber, W. (European Atomic Energy Community, Geel (Belgium). Central Nuclear Measurements Bureau). Oct 1972. 16p. Dep. NTIS (U. S. Sales Only). EUR B.Fr.40.-.

Recently a new method has been proposed for connection of CAMAC to a PDP-11 computer, resulting in a very simple interface and simplified programming. This interface is described in detail, and some programming examples are shown. (auth)

2623 (HMI-B-127) GENERATION OF CALIBRATION MARKS IN A PSEUDORANDOM PULSE HEIGHT UNIFORM DISTRIBUTION. Krueger-Elencwajg, H. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Oct 1972. 29p. (In German). Dep. NTIS (U. S. Sales Only).

A logic circuit is described for generating a uniform pulse height distribution via a digital-to-analog converter. Binary structures (small ranges of higher or lower pulse rate) can be superposed to the uniform distribution. Those structures are usable as calibration marks to check the integral non-linearities of pulse handling systems. The origin of the structures is proven by calculations and the resulting distributions are shown by examples. (auth)

2624 (IRI-133-72-8) WIDE BAND REVERSING TRANSFORMER AS AUTOMATIC BACKING-OFF DEVICE IN NANOSECOND ABSORPTION SPECTROPHOTOMETRY. Luthjens, L. H.; Schmidt, A. M. (Interuniversitair Reactor Instituut, Delft (Netherlands)). 1972. 19p. Dep. NTIS (U. S. Sales Only).

The construction and relevant properties of a high-pass wide band filter with a low frequency cut-off of several kHz and a high frequency cut-off of about 1 GHz to be used with 50 Ω characteristic impedance systems are described. The application to absorption spectrophotometry makes it possible to bring small transient signals on very high levels of analyzing light automatically on the screen of a fast oscilloscope with negligible off-set at high gain settings. (auth)

2625 (KFK-1660) CAMAC: SPECIFICATION OF AMPLITUDE ANALOGUE SIGNALS. PROPOSAL OF THE ESONE WORKING GROUP ON ANALOGUE SIGNALS FOR EUR 5100 (1973) AND COMMENTS. Tradowsky, K. (Kernforschungszentrum, Karlsruhe (West Germany). Labor fuer Elektronik und Messtechnik). Aug 1972. 25p. Dep. NTIS (U. S. Sales Only).

Amplitude analogue signals which are recommended for use by CAMAC compatible units are specified, and the contents of EUR 5100 (1972) and its extension published as KFK 1641 are summarized. There are two classes of signals according to whether their rise times are shorter or longer than 30 ns (corresponding to a 3 db cutoff frequency of approximately 11 MHz). For signals with rise times longer than 30 ns the + 5 volt class (5PB) with 50 Ω output and a matched or unmatched termination is recommended. For signals with rise times shorter than 30 ns the – 1 volt class (1NB) with a terminated 50 Ω system is recommended. (auth)

2626 (LMEC-Memo-68-31) MAGNETIC FLOWMETER PLACEMENT TESTS. Slocomb, H. W.; Carlson, W. J. (Atomics International, Canoga Park, Calif. Liquid Metal Engineering Center). 30 Dec 1968. Contract AT(04-3)-700. 77p. Dep. NTIS.

Tests to determine the effects of upstream and downstream elbows on the accuracy and high-frequency components of a permanent-magnet liquid metal flowmeter signal are described. The effects were determined as a function of flowmeter distance from and orientation with respect to the upstream and downstream elbows. The tests, results, and conclusions are described. (W.H.K.)

2627 (RDT-C-8-4-T) ELECTRICAL CONTINUITY-TYPE LIQUID METAL LEAK DETECTOR. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1972. 23p. Dep. RSO.

A standard prescribing requirements for the design, fabrication, testing, and inspection of two-, three-, and four-wire electrical continuity-type liquid metal leak detectors is presented. The requirements for the electrical circuitry and components associated with these detectors are not included. (W.H.K.)

2628 (TID-25875) CAMAC: A MODULAR INSTRUMENTATION SYSTEM FOR DATA HANDLING. Revised Description and Specification. Costrell, Louis (ed.) (Atomic Energy Commission, Washington, D. C.). Jul 1972. 64p. Dep. NTIS.

CAMAC is a digital data handling system in widespread use with on-line digital processors and computers. The system is based on a digital highway for data and control. Mechanical and signal standards are specified to ensure physical and operational compatibility between units from different sources. Except for pages i-vi, 46A and 46B, this report is identical to EURATOM Report EUR 4100e dated 1972. AEC Report TID-25877 constitutes a supplement to and is to be used in conjunction with this report. This revised specification introduces several new features but is consistent with the previous version (EUR 4100e, 1969). The CAMAC system was specified by European laboratories through the ESONE Committee and has been endorsed by the U. S. AEC NIM Committee. (auth)

2629 (UCRL-73968) CAMAC SYSTEM FOR REMOTE DATA ACQUISITION. Furst, R. C.; Wiedwald, J. D. (California Univ., Livermore. Lawrence Livermore Lab.). 13 Jun 1972. 4p. (CONF-721202-1). Dep. NTIS.

From Nuclear science symposium; Miami Beach, FL. (6 Dec 1972).

A CAMAC system has been developed at Lawrence Livermore Laboratory to interface with a remotely located computer. Two CAMAC compatible read-only controllers are described—one for single crate and one for multiple crate operation. A data display, serial bit stream generator, serial peak detector, 10 ns TIM, and a parallel input gate were developed for the system and are described. (auth)

2630 (UUIP-781) CONSTRUCTION OF A FOCUSING ATOMIC-BEAM MAGNETIC RESONANCE APPARATUS. Ekstroem, C.; Olsmats, M.; Wannberg, B. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1972. 33p. Dep. NTIS (U. S. Sales Only).

A focusing atomic-beam magnetic resonance (ABMR) apparatus has been constructed. The apparatus utilizes a sixpole A-magnet and a fourpole B-magnet, a construction which combines a high transmission with a small collector area. Being intended mainly for work on elements difficult to deflect, i.e., those with high evaporation temperature of small atomic g-value, the ratio of length to radius has been chosen relatively large. An oven construction particularly suitable for high-temperature work is described. The atomic-beam apparatus is equipped with internal detectors for "on-line" detection of short-lived activities. This system has been used in spin-measurements of nuclei with half-lives as short as two minutes. (auth)

2631 EVALUATION OF AN IMPROVED OPTICAL ^{15}N ANALYSER. Karlsson, L.; Middelboe, V. (Royal Veterinary and Agricultural Univ., Copenhagen). pp 211-16 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

For more than a year a Statron NOI-4 nitrogen-15 analyzer has been in operation in this laboratory. This instrument is based on the principle of optic emission spectroscopy, and utilizes the relatively large isotope shifts found in the molecular spectrum of gaseous nitrogen. The nitrogen from a given sample is released by a modified Dumas procedure inside an evacuated and closed discharge tube. The liberated nitrogen gas is excited by means of a modulated short-wave transmitter. The electronic performance of the instrument was not completely satisfactory; in particular this was the case concerning the matching of the emitted to the accepted modulation frequency and the linearity of the output versus the input signal. Consequently, parts of the electronics were changed. The overall performance of the improved instrument was evaluated making use of ten solutions of slightly enriched $(^{15}NH_4)_2SO_4$ provided by the IAEA Laboratory, Seibersdorf, where the solutions had been ^{15}N-analyzed by mass spectrometry. The analyzability of the NOI-4 instrument (using the standard sample preparation procedure) was found to be 4 ng of ^{15}N in 10 to 15 mg of total nitrogen. In this study, the special discharge tubes that are supplied with the instrument for calibration purposes were found to be inapplicable. (auth)

2632 RESEARCH AND DEVELOPMENT OF IN-CORE INSTRUMENTS FOR SODIUM COOLED FAST REACTORS. Ohgushi, Kozo; Hayakawa, Shigeru; Hanamiya, Ikuo (Fuji Electric Co. Ltd., Tokyo). Fuji Jiho; 45: No. 2, 257-63(Feb 1972). (In Japanese).

Brief descriptions are given for in-core flowmeters, devices for measuring outlet temperature of fuel assemblies, and a cyclone type gas separator for fuel failure detection, which were investigated by Fuji Electric Co. for the Power Reactor and Nuclear Fuel Development Corp. From the results of a number of experiments, it seems that the in-core eddy current flowmeter is very promising as an early detection system of abnormal phenomena or an auxiliary means for failed fuel positioning. As for the outlet temperature measuring devices, data that had been obtained were insufficient thus far, accordingly it looks to be difficult to apply the experimental results directly to practical reactors. Although it was found that the cyclone is very effective to gas-liquid separation, more practical tests simulating real operation are required in the future. (Japan)

2633 SOLID STATE DEVICES. Proceedings of the 3rd Conference, Tokyo, September 1–2, 1971. J. Jap. Soc. Appl. Phys., Suppl.; 41: 1-244(1972). (CONF-710965).

Thirty-two papers are included, arranged into sections dealing with bulk-effect devices, amorphous memory, photoelectric devices, MOS devices, other devices, and device technology. Separate abstracts were prepared for three of the papers. (D.L.C.)

For abstracts of individual papers see: 2615, 4331, and 4332.

2634 AMSTERDAM INSTALLATION, GENERATING SEMI-CONTINUOUS FIELDS UP TO 380 kOe. Muller, F. A.; Roeland, L. W.; Gersdorf, R. (Univ., Amsterdam). pp 627-9 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology Hamburg, Germany (19 May 1970). See CONF-700503.

2635 DESIGN AND CONSTRUCTION OF A BITTER SOLENOID HAVING A 26 cm DIAMETER BORE AND GENERATING 16.5 TESLA WITH 26 MW OF POWER. Carden, P. O. (Australian National Univ., Canberra). pp 630-54 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

2636 HIGH-FIELD MAGNET FOR A HYDROGEN ARC EXPERIMENT. Becker, J. D.; Lohnert, H.; Oswald, B.; Zickert, R. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). pp 684-98 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

2637 HIGH FIELD SUPERCONDUCTING SPLIT-COIL MAGNET. Pasotti, G.; Ricci, M. V.; Sacchetti, N.; Sacerdoti, G.; Spadoni, M. (CNEN, Frascati, Italy). pp 896-901 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

FERROMAGNETIC MATERIALS—neutron diffraction studies

MAGNETS—description of high-field superconducting split-coil, for neutron diffraction studies of ferromagnetic alloys (W.H.K.)

2638 TEMPERATURE STABILISED MAGNETO-RESISTOR FOR 0.1 PERCENT MAGNETIC FIELD MEASUREMENT. Welch, E.; Mace, P. R. (Rutherford High Energy Lab., Chilton, Eng.). pp 1377-91 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETOMETERS—description of temperature-stabilized magnetoresistor, for high-energy physics experiments (W.H.K.)

2639 AUTOMATIC COMPENSATED PERMEAMETER FOR TESTING OF ROD SAMPLES. Hansen, N. J. S. (Univ. of Copenhagen). pp 1392-1402 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETOMETERS—description for measuring magnetic permeability of magnet steel

MAGNETS—steel for, permeameter for measuring magnetic permeability of

STEEL—magnetic permeability of magnet, permeameter for measuring (W.H.K.)

2640 AUTOMATIC DYNAMIC FIELD MEASURING SYSTEM. Sack, P.; Schmidt, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 1484-91 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

2641 NEW APPROACH TO HIGH-PRECISION MAGNETIC FIELD MEASUREMENTS. Berkes, B. (Swiss Inst. for Nuclear Research, Zurich). pp 1492-8 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETOMETERS—circuit for temperature effects compensation for Hall (W.H.K.)

2642 TELEMONITORING SYSTEM. Fergus, R. W. (to United States Atomic Energy Commission). U. S. Patent 3,678,512. 18 Jul 1972. Filed 21 Oct 1970.

A multistation monitoring system is interconnected by a single cable. The system may be used for monitoring the status of a door lock, temperature, air flow, personnel monitors, and radiation detectors. Pulses are transmitted over the cable by a signal generator. Each station counts the pulses and upon the receipt of the appropriate pulse each station changes the pulse width according to the data to be transmitted. Provision is also made to transmit control pulses which can be used to activate controls at remote locations. (auth)

2643 MOMENTUM SPECTROMETER. Kleinwaechter, Hans. U. S. Patent 3,686,500. 22 Aug 1972. Priority date 24 May 1965, Germany.

A magnetic mass spectrometer of very high dispersion and high resolving power is described. At the same time, the technical expenditure involved, especially the weight of the magnets and the physical dimensions of the magnets and of the vacuum chamber, are kept extremely small. The spectrometer comprises a special magnetic dispersion field with merely dispersing but no focusing properties. The dispersion field is made up of several magnetic homogeneous fields with straight, parallel field boundaries for the entrance and the exit of ions, called "magnetic prisms" which are successively transversed by the ions. The homocentric beams of ions emanating from the ion source are converted by electric or magnetic lenses into parallel beams which are conducted to the dispersion field. After leaving the dispersion field, the parallel ion beams are focused again by electric or magnetic lenses and passed into the means for collecting the ions. The use of a larger number of "magnetic prisms" successively traversed by the ions will generate any desired degree of dispersion. (auth)

2644 IMPROVEMENT OF RADIATION PROTECTION IN PREIONIZATION OF GAS DISCHARGE TUBES. Makedanz, A. (Staatliche Zentrale fuer Strahlenschutz, Berlin). Z. Gesam. Hyg. Ihre Grenzgeb.; 17: 554-8(Aug 1971). (In German).

Based on the present state of technology, radiation protection was studied with respect to application of natural and artificial radioactive substances for preionization of gas discharge tubes. The radiation burdens resulting from radium suspensions and from ^{85}Kr were quantitatively compared. By switching to ^{85}Kr, the radiation burden could be lowered to less than $1/10$. Suggestions were listed for radiation protection during use of ^{85}Kr. (2 figures, 4 tables) (tr-auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

Isotope Separation (Industrial)

Refer also to abstract 2482.

2645 (EUR–4796) BIBLIOGRAPHY ON URANIUM ISOTOPE SEPARATION. Schiel, R. (European Atomic Energy Community, Luxembourg. Center for Information and Documentation). Nov 1972. 254p. Dep. NTIS (U. S. Sales Only). EUR B.Fr. 320.–.

A compilation of 1096 abstracts on uranium isotope separation is presented. The bibliography is subdivided according to different separation methods, to economical aspects, and to already existing bibliographies on isotope separation. In addition, an Author Index, and a Report and Patent Number Index are given. (auth)

2646 (KFK–1630) THEORETICAL INVESTIGATION OF A VISCOUS COMPRESSIBLE FLOW IN A CURVED NOZZLE. Duerr, R. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik). Sep 1972. 59p. (In German). Dep. NTIS (U. S. Sales Only).

For calculation of the flow and energy losses of pure gases in the separation nozzle geometry, the Navier–Stokes equations are simplified and solved by numerical integration using the finite difference method. It is shown by comparison with pressure measurements that the results are a satisfactory approximation of the experiments, especially in the range of small and medium-size deflection angles. The flow entering the nozzle tangential to the deflection wall adapted itself to the curved nozzle after approximately 30° of deflection and did not show major deviations from a parabolic shape in the azimuthal velocity profile below Reynolds numbers of 200. The temperature curve largely corresponded to that of an isoenergetic flow. Quantitatively, the entropy calculations agreed with the behavior measured in the experiment. Analysis of the distribution of losses within the separation element shows the losses to be highest in the initial third of the nozzle, due to the steep velocity gradient and the shape of the inlet profile. (auth)

2647 (KFK–1634) INFLUENCE OF HEAT TRANSFER PROCESSES ON FLOW AND MIXING IN THE SEPARATION NOZZLE INVESTIGATED WITH FREE MOLECULAR PRESSURE AND TEMPERATURE PROBES. Ehrfeld, U.; Ehrfeld, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik). Jul 1972. 69p. (In German). Dep. NTIS (U. S. Sales Only).

The flow and temperature fields in the separation nozzle as well as the effect of heat transfer between heated nozzle walls and the gas flow on flow profiles and demixing were studied by means of combined measurements with free molecular pressure and temperature probes in He/Ar and He/SF_6 gas mixtures. It has been pointed out that a strong interaction exists between demixing of the components, on the one hand, and the heat transfer within the flow and heat exchange with the surrounding walls, on the other hand. The flux of kinetic energy associated with demixing and directed towards the deflection wall results in a radially differing stagnation temperature; however, the radial gradients of the static temperature, originally generated during the acceleration of the gas in the nozzle, become equalized due to demixing, as can be shown by comparison of experiments using pure helium. Heat transfer between the heated nozzle walls and the flow has only little effect upon the molecular speed ratio. However, the rate of demixing of the components becomes considerably modified by the heat transfer towards the flow. The separation factor of the two components decreases near the deflection wall and increases in the inner flow regions, since the deflection wall is heated. Heating of the inner nozzle plate increases the separation factor of up to 20% over the total cross section can be maintained. (auth)

2648 TECHNICAL BASIS OF THE GAS CENTRIFUGE. Olander, Donald R. (Univ. of California, Berkeley). Advan. Nucl. Sci. Technol.; 6: 105–74(1972).

The gas centrifuge or ultracentrifuge is a device which separates the isotopes of U by the action of a centrifugal force field some 10^5 times greater than gravity, and is of special interest to countries with low electrical generating capacity because the gas centrifuge process requires only about one-fifth the electric power of the gaseous diffusion process. Of the three types of centrifuges, i.e., concurrent, countercurrent, and evaporative, only the countercurrent is seriously considered for large-scale application. An analysis of the performance of the countercurrent gas centrifuge is presented based primarily upon the equations of diffusion and hydrodynamics which govern the phenomena occurring in the device. (L.C.L.)

2649 PROCESS AND APPARATUS FOR CONCENTRATING ISOTOPES BY THE SIMULTANEOUS EXCHANGE OF HEAT AND MASS. Thayer, Victor R. U. S. Patent 3,685,967. 22 Aug 1972. Filed 4 Aug 1969.

The method and apparatus disclosed relates to the production of a concentrate of an isotope of an element by chemically exchanging at different temperatures isotopes of the same element between chemically different fluids, which are physically separable from each other and which are capable of containing each of the isotopes. According to the method, both heat and isotopes are exchanged between the fluids simultaneously while the fluids are flowing countercurrently with respect to each other within a temperature gradient. Conduits positioned within an exchange tower recirculate one or both of the fluids to permit simultaneous direct and indirect heat exchange as well as isotope exchange between the fluids. (Official Gazette)

2650 SINGLE UTILITY ELECTRIFIES NOVA SCOTIA. Mod. Power Eng.; 66: No. 8, 56-7(Aug 1972).

A brief discussion is given of the production of heavy water at Port Hawkesbury, and more on the program for rehabilitating the hitherto unsuccessful heavy water plant at Glace Bay. Dismantling at Glace Bay is almost complete. The process is being modified to use fresh water instead of seawater. The existing towers are being modified. The three stage GS process will produce water with an isotopic content corresponding to 20% D_2O, and this will be upgraded in two distillation columns. Nova Scotia has no plans for nuclear generating plant at present, and is giving only preliminary consideration to the possibility of generating power from tides in the Bay of Fundy. (Canada)

2651 METHOD OF SEPARATING ISOTOPES. Gurs, Karl (to Battelle-Institut eV). British Patent 1,284,620. 9 Aug 1972. Filed 23 Dec 1970.

The method described is based on laser beam irradiation, whereby gaseous molecules containing a first isotope are excited but those containing a second isotope are not excited. The excited molecules are then chemically converted and separated from the unconverted molecules, for example by fractional distillation. The method may be applied to $^{235}U/^{238}U$. Alternatively, one or more core reactants that react preferentially with the activated molecules are added to the irradiated gas. The gas may also comprise a compound, such as $U(BH_4)_4$, that decomposes as a result of the irradiation, in which case addition of a core reactant is unnecessary. A CO_2 laser may be employed, and in the case of U the gas may be comprised of UF_6 or UCl_6, and also molecules such as $U(BH_4)_4$. (UK)

2652 RECOVERY OF HYDROGEN SULPHIDE FROM WATER. Nazzer, Don Barkley; Thayer, Victor R. (to Canadian General Electric Co. Ltd.). British Patent 1,285,077. 9 Aug 1972. Filed 27 Oct 1969.

Reference is made to methods for stripping H_2S from the effluent of the hot and cold tower H_2S/H_2O process for the production of D_2O. In the method described at least a portion of the water and absorbed gas is extracted after passage through the hot zone, the pressure of the extracted liquid is reduced by flashing through one or more throttles to remove a portion of the gas, the liquid then being passed through fractionating means to remove more of the gas. All the removed gas is then recompressed and returned to the exchange process by absorption in the feed water, with recovery of heat from the water leaving the fractionating means. (UK)

2653 HEAVY WATER PRODUCTION. Levins, D. M.; Alfredson, P. G. (Australian Atomic Energy Commission, Coogee). At. Energy Aust.; 15: No. 3, 2-11(Jul 1972).

Heavy water production methods are reviewed and the chemical separation processes that are involved are described. These processes include hydrogen sulfide/water exchange, ammonia/hydrogen exchange, amine/hydrogen exchange, and hydrogen/water exchange. Distillation and electrolysis methods are also outlined. (Australia)

2654 PHYSICAL PROPERTIES OF HYDROGEN, DEUTERIUM, AND TRITIUM. Muetterties, E. L. (E. I. du Pont de Nemours and Co., Wilmington, Del.). pp 1-9 of Transition Metal Hydrides. /Muetterties, E. L. (ed.). New York; Marcel Dekker, Inc. (1971).

The properties discussed include isotopes and nuclear spin isomers, nuclear properties, solid state, liquid state, gaseous state, thermodynamic properties, and solubility. (35 references) (D.L.C.)

2655 EXPERIMENTAL AND THEORETICAL INVESTIGATION OF THE STATIONARY OPERATIONAL BEHAVIOR OF

CASCADE SEPARATION NOZZLES FOR THE ENRICHMENT OF ^{235}U. Schuette, R.; Seidel, D.; Fritz, W.; (and others) (Kernforschungszentrum, Karlsruhe, Ger.). Chem.-Ing.-Tech.; 44: No. 19, 1099-1104(Oct 1972). (In German).

The control of a cascade of separation nozzles under desired operational conditions and its supervision in stationary enrichment was investigated. Digital computer programs were developed for calculating the operational behavior. The investigations showed that deviations from theoretical values in the operational parameters of the separation nozzles and the compressors or control operations in each stage or in the UF_6 separation plant take effect in only a limited number of neighboring stages. A change in the transport of the make-up gas influences the operational values of each stage of the cascade by about the same amount. (auth)

2656 EFFECT OF GEOMETRICAL PARAMETERS ON THE EFFICIENCY OF SEPARATION NOZZLE ELEMENTS IN THE ENRICHMENT OF ^{235}U. Weis, F. Karlsruhe, Ger.; Karlsruhe Univ. (1971). 39p. (In German).

Thesis.

Systematic experimental and theoretical investigations were carried out to study the influence of geometrical parameters and their variations on the performance of separation nozzle elements. The influences of nozzle width, height setting of the nozzle plate tip, skimming width, height setting of the skimmer plate, as well as of the shapes of the inlet edge and the skimmer blade edge, on the separating properties of the separation system have been investigated with the aid of a double-chamber separating apparatus. On the basis of the results obtained tolerance limits of the critical dimensions for mass fabrication are given. (GF)

Isotopic Power Sources

Refer also to abstract 2867.

2657 (CONF-721109-7) PROGRESS IN THE DEVELOPMENT OF ^{244}Cm RADIOISOTOPIC POWER FUEL. McHenry, R. E.; Butler, T. A. (Oak Ridge National Lab., Tenn.). [nd]. 5p. Dep. NTIS.

From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

A summary of development progress in high-power density thermal energy sources of ^{244}Cm is presented. It is concluded that the high melting point and high-power density of Cm_2O_3 afford a flexible range of power converter operations. (J.R.D.)

2658 (GEMS-3535-5(Vol.1)) SNAP-27, Quarterly Report No. 5, October 1, 1966-December 31, 1966. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). 1966. Contract AT(30-1)-3535. 474p. (67-SD-2007(Vol.1)). Dep. NTIS.

Declassified 27 Oct 1972.

Research and development progress is reported in sections on systems engineering, safety, quality assurance, reliability, and generator assembly. (J.R.D.)

2659 (IESD-2960-53) SNAP 19 RTG FOR VIKING LANDER SYSTEM, First Semiannual Progress Report, January 1-June 30, 1972. (Teledyne Isotopes, Timonium, Md. (USA). Energy Systems Div.). Aug 1972. Contract AT(29-2)-2960. 230p. Dep. NTIS.

During this reporting period, the technical activities associated with the development, design and testing of the SNAP 19 Viking RTG were continued. The major technical efforts included: continued development of a high temperature electrical receptacle-to-generator housing hermetic seal, initiated development of a fuel capsule helium vent system for venting the radioisotope fuel-produced helium external to the generator housing, initiated testing to determine the effect of Mars surface thermal cycling on generator electrical performance, and initiated design studies for assembly and test of an Engineering ETG. (auth)

2660 (WANL-3559-1) FPMS LIFE TEST ANNUAL REPORT. Van Bibber, L. E. (Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.). Jul 1972. Contract AT(11-1)-3559. 29p. Dep. NTIS.

The SNAP-23A Fueled Prototype Mockup System has been on system thermal and life test since February 1970. It has accumulated 18,700 hours of testing through June 30, 1972 of which 17,070 have been accumulated on life test with the Prototype Mockup Converter PMC-3. On June 30 the system was producing 63 watts at an overall efficiency of 6.1 percent. The fuel power level was 1025 watts corresponding to 5.7 years from the nominal fuel design loading of 1180 watts. During the life test period the system has performed as predicted without any apparent degradation of system components and interfaces. The only change in performance has been that due to fuel decay. (auth)

2661 NUCLEAR PACEMAKERS. Carleson, G. (Aktiebolaget Atomenergi, Studsvik, Sweden); Kugelberg, J. Laekartidningen; 69: No. 30, 3497-3500(1972). (In Swedish).

It is expected that it will be possible to extend the period of operation of pacemakers to 10 years or more, if the present-day source of power (mercury cells) is replaced by a nuclear cell with the artificial radioisotope, plutonium-238, as the initial energy generator. The technical and clinical experience gained in prototype-development work in Europe, including Sweden, is presented and discussed in relation to the safety problems for which internationally accepted solutions must be found before the nuclear pacemaker can be introduced onto the commercial market. (auth) (Sweden)

Radiation Sources

Refer also to abstracts 2495 and 4384.

2662 (AECOP-754) POTENTIAL MARKET FOR BY-PRODUCT CESIUM FROM COMMERCIAL POWER REACTORS. Wood, P. M.; Harrel, H. A. (Atomic Energy Commission Combined Operations Planning, Oak Ridge, Tenn.). 20 Apr 1971. Contract W-7405-eng-26. 41p. Dep. NTIS.

The potential market for by-product cesium from commercial power reactors is analyzed. The competition between cesium isotopes and ^{60}Co for large-volume applications is discussed. (T.F.D.)

2663 TECHNIQUE FOR THE MEASUREMENT OF DESORPTION RATES OF ^{3}H FROM ^{3}H-ABSORBED METALLIC SOURCES. Indra, R. N.; Kulkarni, B. A. (Bhabha Atomic Research Centre, Bombay). Indian J. Technol.; 10: No. 3, 88-91(Mar 1972).

The desorption of ^{3}H from metallic ^{3}H targets and sources has been experimentally studied in argon atmosphere under static conditions, using an ionization chamber. The activity desorbed in the closed atmosphere has been observed to increase and reach a saturation value. The trend of increase in the desorbed activity has been studied. Assuming that reabsorption of ^{3}H also occurs, a theoretical explanation for the process leading to saturation has been worked out. The value of the desorption rate, independent of reabsorption, has been deduced. An attempt has also been made to calculate the probability for a ^{3}H molecule to be reabsorbed when it impinges on the source. It is concluded that continuous loss of ^{3}H by desorption from the sources can be prevented by enclosing them in gas-tight containers. (auth)

2664 IMPROVEMENTS TO SELFLUMINESCENT LAMPS. (to Laboratoires Lumina). French Patent 2,105,522. 28 Apr 1972. Filed 10 Sep 1970. (In French).

A self-luminescent lamp is described which possesses an envelope which is at least partially transparent. This envelope is coated internally with a phosphor and filled with a radioactive gas (tritium or ^{85}Kr). The envelope possesses a convex surface which faces a concave surface. (France)

Design and Fabrication

2665 (BNWL-SA-4392) RF SPUTTERING OF THIN FILM RADIATION SOURCES AND HAZARDOUS MATERIALS. Riemath, W. F.; Culver, G. G.; Jarrett, J. H. (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. 20p. (CONF-720945-2). Dep. NTIS.

From Annual symposium of Pacific Northwest section, American Vacuum Society; Vancouver, B. C. (8 Sep 1972).

Preparation of high-activity, high-integrity thin-film radiation sources using rf-sputtering is described. Cermets composed of $^{242}AmO_2$-Cu were used as targets. Copper and stainless steel substrates were used. Proper use of glove boxes is described. (J.R.D.)

Industrial Uses

Refer also to abstracts 2673, 2676, 2677, and 2725.

2666 NEW RADIATION-PROCESSING SYSTEM. Hoffman, C. R. (High Voltage Engineering Corp., Burlington, Mass.). Mod. Packag.; 45: No. 9, 60-2(Sep 1972).

A compact and economical unit for the radiosterilization of containers and packaging materials using accelerated electrons is described. (T.F.D.)

2667 RADIOACTIVE ISOTOPES SOLVE INDUSTRIAL AND PROCESSING PROBLEMS. James, P. A. (Univ. of New South Wales, Kensington, Australia). At. Energy Aust.; 15: No. 3, 20-6(Jul 1972).

Applications described are analysis of pharmaceutical tablets using radioactive material in the formulation, mixing time studies

in the food industry, water leakage detection from tuyères in the smelting industry, and density measurements of materials. (Australia)

2668 SPROUT INHIBITION OF POTATOES BY IONIZING RADIATION. 3. DOSE TO INHIBIT SPROUT AND THE CHANGE IN SUGAR CONTENT DURING THE LOW TEMPERATURE STORAGE. Takano, Hiroyuki; Tanaka, Yoshiichi; Umeda, Keiji; Sato, Tomotaro (Food Research Inst., Tokyo). Shokuryo Kenkyujo Kenkyu Hokoku; No. 27, 64-9(Mar 1972). (In Japanese).

Effects of γ-irradiation on sprouting and sugar content during the low temperature storage of irradiated potatoes of var. Norin-1-go and var. May Queen were investigated. 7000 rad was enough to prevent sprouting for more than eight months after harvest at room temperature. Under the low temperature storage, the reducing-sugar content of potatoes was increased gradually and this high reducing-sugar content caused the browning of crisps made of irradiated potatoes. The reducing-sugar content was decreased and the browning of crisps was prevented provided the potatoes were kept at room temperature (April in Tokyo) for two weeks, or at the higher temperature such as 20°C for two weeks, 25°C for 10 days, or 28°C for 6 days. (Japan)

2669 RADIATION TREATMENT OF RICE. 3. EFFECT OF POST IRRADIATION STORAGE TO THE ORGANOLEPTIC QUALITY OF RICE. Takano, Hiroyuki; Tanaka, Yoshiichi; Umeda, Keiji; Sato, Tomotaro (Food Research Inst., Tokyo). Shokuryo Kenkyujo Kenkyu Hokoku; No. 27, 17-23(Mar 1972). (In Japanese).

Effects of post-irradiation storage on the organoleptic quality of rice were examined. The rice was irradiated at the doses of 20,000 and 50,000 rad and stored at 10 and 30°C for 7 months. Organoleptic tests were conducted immediately and 1, 3, 5 and 7 months after the irradiation and compared with non-irradiated sample. Organoleptic deteriorations were detected immediately after the irradiation on both of irradiated samples. But after more than one month of storage, no significant differences were detected between the non-irradiated sample and the irradiated samples. Regardless of irradiated or non-irradiated samples, organoleptic quality of rice stored at 30°C has gradually deteriorated during storage, but little deterioration was detected on the samples stored at 10°C. (auth)

2670 WEAR MEASUREMENTS USING MoS_2-LUBRICATING OIL ADDITIVES ON PISTON RINGS OF A FOUR-CYLINDER OTTO ENGINE BY MEANS OF RADIOISOTOPES. Schadow, G. Motortech. Z.; 33: No. 5, 193-5(1972). (In German).

The wear properties of a piston ring in a Renault R-4 motor were studied with and without the addition of MoS_2 to the lubricating oil using neutron activation of the piston ring. The results show a significant wear decrease of the rolling surface of the upper piston ring by adding a mixture of MoS_2 to the lubricating oil. (GF)

LIFE SCIENCES

Radiation Effects on Biochemicals

Refer also to abstract 2694.

2671 (COO-78-283) THREE YEAR REPORT, MAY 1, 1969-APRIL 30, 1972. Friedell, Hymer L. (Case Western Reserve Univ., Cleveland, Ohio. Dept. of Radiology). [nd]. Contract W-31-109-eng-78. 60p. Dep. NTIS.

Research activities during 1969 to 1972 are reported in the following areas: radiation physics; radiation cytology; radiation biochemistry; radiation modifiers; and radioisotope applications. Summaries of the following projects are included: ionization in liquids; scintiscanning and nuclear medicine; cell volume and membrane phenomena; electrical counting and sizing of cells; radiation effects on mammalian cells; role of protein synthesis in radioinduced mitotic delay; characteristics and replication of DNA of Physarum polycephalum; radiation effects on synthesis of DNA, RNA, and proteins; configuration of DNA of Bacillus subtilis spores; interaction of manganese ions with DNA and deoxynucleosides; modification of cellular radiation response through transient metabolic alteration with glucose; effects of deoxyglucose on radiation response of cultured cells; effects of elevated temperatures on radiation response of cultured cells; DNA replication and repair of radioinduced DNA strand breaks in Physarum polycephalum; and radioisotope applications in nuclear medicine. (E.R.B.)

2672 (COO-3276-4) FLUORESCENCE ASSAY OF NUCLEIC ACID PHOTODAMAGE. Hauswirth, William; Wang, Shih Yi (Johns Hopkins Univ., Baltimore, Md. Dept. of Biochemistry). 1972. Contract AT(11-1)-3276. 14p. Dep. NTIS.

A documentation of the fluorescence properties of the pyrimidine photoadducts and the observation of similar spectra in UV irradiated DNA's and poly-nucleotides implies that adduct formation may be monitored in biological systems by its emission signal. The fixed ratio of photochemical yields between adducts and other lethal products also suggest the use of adduct fluorescence to assay directly the degree of photodamage in DNA. (auth)

2673 EFFECT OF IRRADIATION ON THE NUTRITIONAL QUALITY OF PROTEIN IN POTATOES. Varela, G.; Urbano, Gloria (Univ., Granada, Spain). Agrochimica; 16: No. 1-2, 171-6(Dec 1971). (In Spanish).

The influence is examined of an 8-Krad irradiation of potatoes of the "Cire" variety, 30 days after harvesting. Also examined is the influence of the post-irradiation storage period on the nutritional qualities of their proteins, making use of the Mitchell's technique based on the balance of nitrogen in the rates of growth. The authors also study the influence of irradiation on the amino acid contents, and on the lysine fraction available according to Carpenter. In general, the treatment has no significant effects on digestibility, or on the proteins' biologic value. (auth)

2674 EFFECTS OF GAMMA IRRADIATION ON PROTEASES OF RENNETS AND THEIR SUBSTITUTES. Masek, J. (Development Plant of Dairy Industry, Prague); Mikova, L.; Teply, M.; Havlova, J.; Hosek, K. Prum. Potravin; 22: No. 7, 220-2(Jul 1971). (In Czech).

The results are presented of studies on the effect of gamma irradiation on the activity of various curdling proteases, such as the proteases prepared from strains of Bacillus subtilis, from a microbial rennet, from the gastric juice extracted in vivo from the abomasums of calves, from rennets prepared from dehydrated stomachs, and from rennets from the stomachs of kids and pigs. The reduction in activity was studied in relation to the radiation dose, and the feasibility was investigated of using gamma irradiation for the elimination of microflora from the above preparations and/or rennets. The results are given in tables indicating that a dose of 4×10^6 R ensuring the sterility of the preparations resulted in a reduced activity of the rennets by 11 to 75%. Such microbiological pre-purification should therefore be selected as will reduce the number of microbes to a permissible level by a dose of 3×10^6 R, which only slightly affected the activity of the rennets. (NSA of Czech.)

2675 IN VITRO REPAIR OF SINGLE-STRAND BREAKS IN γ-IRRADIATED DNA BY POLYNUCLEOTIDE LIGASE. Jacobs, A.; Bopp, A.; Hagen, U. (Kernforschungszentrum, Karlsruhe, Ger.). Int. J. Radiat. Biol.; 22: No. 5, 431-5(Nov 1972).

The ability of polynucleotide ligase to eliminate single-strand breaks in γ-irradiated DNA (doses of 1, 2, or 5 Krads) was studied. The irradiated DNA was first labeled at the 5'-end of the break with ^{32}P-phosphate and treated in vitro with polynucleotide ligase. In phosphoester-bonds joined by the ligase, the incorporated ^{32}P-phosphate was resistant to subsequent phosphatase treatment. The number of sealed breaks, detected in this way, was compared with the total number of single-strand breaks measured in the analytical ultracentrifuge. In DNA with 0.4 to 2.0 radiation-induced single-strand breaks/1000 nucleotides, up to 40% of the breaks could be joined directly by the ligase. (auth)

2676 FLAVOR SENSITIVITY OF SELECTED ANIMAL PROTEIN FOODS TO GAMMA RADIATION. Sudarmadji, S.; Urbain, W. M. (Michigan State Univ., East Lansing). J. Food Sci.; 37: No. 5, 671-2(1972).

The relative sensitivities of raw protein foods derived from animals of different biological classification to ^{60}Co γ radiation and the threshold doses for flavor changes of the foods studied were determined. No evidence was found of a relationship between flavor sensitivity of a food and the biological classification of the animal from which it was derived. The threshold dose for production of a slight irradiation flavor ranged from a low of 150 krads for turkey to a high of 875 krads for bear meat. (E.R.B.)

2677 EFFECT OF GAMMA RADIATION ON WHEAT PROTEINS. Srinivas, H.; Ananthaswamy, H. N.; Vakil, U. K.; Sreenivasan, A. (Bhabha Atomic Research Centre, Bombay). J. Food Sci.; 37: No. 5, 715-18(1972).

The radiosensitivity and enzymic susceptibility of wheat proteins in situ and of isolated gluten were determined. There was no appreciable change in the amino acid composition of the wheat protein or the isolated gluten due to radiation treatment at doses below 1 Mrad. Evidence of autolysis was observed in the irradiated wheat floor. It was suggested that radiation treatment could result in the degradation of wheat proteins to lower molecular weight peptides and amino acids. (E.R.B.)

2678 IMPAIRMENT AND REPAIR OF THE NUCLEIC ACIDS. Kondo, Sohei (Osaka Univ.). Iden; 25: No. 9, 49-54(Aug 1971). (In Japanese).

The structure and replication of genetic information and the law for the transfer of information (DNA → RNA → protein) were described. Discontinuities of DNA due to disruption by ^{32}P decay within the cell, impairment of DNA due to external ionizing radiation, and repair by resumption of the discontinued chain were detailed. Impairment of DNA base, photo-recovery, excisions-repair, and recombination-repair were described. Citing xeroderma pigmentosum as an example, impairment and repair of the nucleic acids in higher organisms were detailed and their evolutional significance was referred to. When there is no error in genetic information there could be no evolution of living things, but too many errors ruin them. Living things have followed the history of evolution over 30 and several hundred million years on a subtle balance between formation and control of errors. Impairment and repair of DNA support this balance. (Japan)

2679 STEPS IN DNA CHAIN ELONGATION AND JOINING AFTER ULTRAVIOLET IRRADIATION OF HUMAN CELLS. Buhl, S. N.; Setlow, R. B.; Regan, J. D. (Oak Ridge National Lab., Tenn.). Int. J. Radiat. Biol.; 22: No. 5, 417-24(Nov 1972).

It is pointed out that the DNA synthesized in human cells shortly after uv-irradiation is of lower molecular weight than that in unirradiated cells. Within several hours after irradiation, these smaller DNA units are both elongated and joined together. To determine if this process involves incorporation of exogenous precursors, cells were irradiated, pulse-labeled, and incubated in medium containing bromodeoxyuridine. They were then exposed to different fluxes of 313 nm radiation, and the number of breaks in the DNA was determined by sedimentation in alkaline sucrose. If bromodeoxyuridine, rather than exclusively premade DNA were used to elongate and join the small DNA segments synthesized after uv-irradiation, photolysis of 313 nm radiation would yield the lower molecular weight segments that are present immediately after uv-irradiation. This expectation was fulfilled, and results indicated that the mechanism of filling the gaps in DNA synthesized after irradiation involved the insertion of ~10^3 nucleotides per gap in both normal human cells and those from individuals with xeroderma pigmentosum. (UK)

2680 CHANGES IN THE SOLUBLE MUSCLE PROTEINS AND ISOENZYMES OF LACTATE DEHYDROGENASE IN IRRADIATED BEEF MEAT. Uzunov, G.; Tsolova, L.; Nestorov, N.

(Meat Tech. Research Inst., Sofia). Int. J. Radiat. Biol.; 22: No. 5, 437-42(Nov 1972).

Gamma-irradiation of the longissimus dorsi muscle of two-year-old cattle with 1, 2.5, and 5 Mrads showed that the electrophoretic characteristics of the soluble proteins changed. The relative values of cathodic fractions of proteins decreased with increasing dose. The total content of soluble proteins decreased linearly with dose. Similar behavior was observed for fractions of the lactate dehydrogenase isoenzymes. With increasing dose of radiation, LDH-2 activity decreased and was lost above 2.5 Mrads, and LDH-3 showed very low values. LDH-4 and LDH-5 were more resistant to radiation. The total LDH activity dropped very rapidly with dose as a result of the destruction of LDH-2. (auth)

2681 ESR STUDY OF AMINO ACID AND PROTEIN FREE RADICALS IN SOLUTION. 5. ESR STUDY OF GAMMA-IRRADIATED LYSOZYME IN FROZEN AQUEOUS SOLUTIONS. Hong, S. J.; Piette, L. H. Daehan Hwahak Hwoejee; 16: No. 1, 40-53 (1972).

An electron spin resonance study was made on lysozyme in frozen aqueous solutions irradiated with ^{60}Co γ rays in air at 77°K. Water resonances are dominant when the concentration and the temperature are both below 20% and 130°K respectively. More solute radicals are produced in the solution of higher concentration. Majority of the solute radicals results from direct hit of the radiation. The same types of radicals are induced at 77°K whether the substances are irradiated in the dry state or in frozen aqueous solution. Based on these results, it is assumed that the number of ESR centers produced by the secondary intermolecular radical reactions and stabilized in aqueous solutions may depend on the concentration of the solution, and the presence of water may facilitate the secondary radical reactions occurring in the solute molecules after heat treatment. Majority of the solute radicals above around 193°K are believed to react with oxygen to form peroxy-type radicals. However, when the solution is subjected to heat-treatment at 265°K after irradiation at 195°K the peroxy-type resonance was not observed, suggesting that an appreciable amount of oxygen is condensed into the ice, at 77°K, in addition to the oxygen that has already been dissolved in solution and react with solute free radicals during the process of heat-treatment. When the solution contains H_2O_2, no water resonance but $HO_2\cdot$ type resonance was observed probably indicating that the radiation-induced OH radicals are trapped in H_2O_2 aggregates and react readily with H_2O_2 molecules to produce $HO_2\cdot$ type radicals even at 77°K. (Korean Sci. Abstr.)

2682 HEAVY-ION-INDUCED SINGLE- AND DOUBLE-STRAND BREAKS IN PHI X-174 REPLICATIVE FORM DNA. Christensen, R. C.; Tobias, C. A.; Taylor, W. D. (Univ. of California, Berkeley). Int. J. Radiat. Biol.; 22: No. 5, 457-77 (Nov 1972).

Damage caused by accelerated atomic nuclei was measured in ϕX-174 Replicative Form I (RF I) DNA as a function of linear-energy transfer (LET). Irradiations were performed at room temperature in a highly radioprotective broth to minimize the effects of free radicals. Most ion beams terminated in the continuously-mixed samples. By using neutral sucrose gradient sedimentation of ^{3}H-TdR-labelled RF DNA, irradiated samples were assayed for relative proportions of RF I (supercoil), RF II (open coil), and RF III (linear) DNA configurations. A spheroplast assay was used to determine the viability of DNA samples. The efficiency of production (per rad) of single-strand break events decreased 3-fold over the LET range investigated, whereas double-strand break production increased 5-fold. The ratio of single-strand break events to double-strand breaks varied from about 26 : 1 for ^{60}Co gamma-irradiation, to about 2 : 1 for charged particle irradiation. Double-strand breaks accounted for less than 10% of the observed loss of viability at low LET, rising to about 50% at high LET. Alkaline sucrose gradient determinations of total DNA break events at low LET yielded consistently greater values than did analogous neutral sucrose determinations, suggesting the presence of induced alkali-labile bonds in irradiated DNA. (auth)

2683 ESR STUDY OF AMINO ACID AND PROTEIN FREE RADICALS IN SOLUTION. 6. ENZYMATIC INACTIVATION OF LYSOZYME IN AQUEOUS SOLUTIONS RESULTING FROM EXPOSURE TO Ti-H_2O_2 SYSTEM AND GAMMA-IRRADIATION. Hong, S. J.; Piette, L. H. Daehan Hwahak Hwoejee; 16: No. 2, 80-3(1972).

The activity change of lysozyme resulting from its exposure to Ti-H_2O_2 system in aqueous liquid at room temperature and to γ irradiation in ice at 195°K was measured at room temperature with a Cary-14 spectrophotometer. The enzymatic activity of lysozyme that was added to a previously flow-mixed solution of $TiCl_3$ and H_2O_2 (system I) was compared with the activity of a lysozyme-H_2O_2 solution after flow-mixing with $TiCl_3$ (system II), considering the differences between these two activity changes as the extent of the enzymatic inactivation by the involvement of OH radical reaction. The fraction of lysozyme inactivated by OH radical in the system containing 0.0025 M $TiCl_3$–0.1 M H_2O_2 (pH 3.5) was 13%. When the $TiCl_3$ concentration is double (pH 3.0), the fraction of enzyme inactivated increases to 36%. The activity of the system containing 0.025 M $TiCl_3$-0.1 M H_2O_2 (pH 1.5) was essentially zero. The results seem to support the previous view that the production of OH radical should be proportional to $TiCl_3$ concentration when H_2O_2 is present in excess. Increase in the extent of inactivation found in system I with increasing $TiCl_3$ concentration may be due to a pH effect. H_2O_2 seems to be less effective than $TiCl_3$ in the inactivation. 1% lysozyme solution, when γ-irradiated with a total dose of 3M rads, loses about 20% of its activity. Lowering of temperature also was found to yield a reduction in enzymatic activity. (Korean Sci. Abstr.)

Radiation Effects on Cells

Refer also to abstracts 2671, 2764, and 2803.

2684 (AEC-tr-7362, pp 16-23) **INFLUENCE OF RADIATION ON THE ACTIVITY OF ALKALINE PHOSPHATASE IN THYMOCYTE NUCLEI.** Dak L'eu, Le; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 12: No. 2, 171-5(1972).

The effects of x irradiation on the activity of alkaline phosphatase in nuclei of rat thymocytes in the incubation medium and on the surface of the nuclear membranes in Creasy's medium and shock medium were studied. It was shown that the activity of the enzyme in the incubation medium is unchanged even after irradiation at doses of 1000 and 2000 R, both in vitro and in vivo. Its activity on the surface of the membrane in experiments in vitro and in vivo is clearly changed after irradiation both in the case of incubation in Creasy's medium and in shock medium; moreover, after a dose of 200 R, the activity of the enzyme is somewhat reduced, while at doses of 500, 1000, and 2000 R it is increased. (tr-auth)

2685 (ORO-3884-1) **RADIOBIOLOGIC EVALUATION OF AN IN VITRO MAMMALIAN CELL RENEWAL SYSTEM.** Terminal Progress Report. Dalrymple, G. V.; Sanders, J. L.; Nash, J. C. (Veterans Administration Hospital, Little Rock, Ark.). 25 Sep 1972. Contract AT(40-1)-3884. 63p. Dep. NTIS.

Procedures are described for experiments on: survival of irradiated Chinese hamster cells and rat sarcoma cells; use of polynucleotide kinase to measure the kinetics of rejoining of post-irradiation DNA breaks; ultracentrifuge methods; determination of rate of synthesis of DNA, RNA, and protein by measuring rate of incorporation of ^{3}HTdR, ^{3}HUR, and ^{3}H leucine into the DNA, RNA, and protein components of the cell acid insoluble fraction; and autoradiographic methods. Results of experiments with hamster cells and rat sarcoma cells are discussed. A literature review is presented of the generation cycle analysis of rat sarcoma cell lines with regard to the time of the cell cycle, the size of the proliferative pool, and the times of the phases of the cell cycle. (H.L.W.)

2686 RADIOSENSITIZATION OF ASYNCHRONOUS AND SYNCHRONOUS MAMMALIAN CELL POPULATIONS BY p-NITROACETOPHENONE. Chapman, J. D. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 286-8(Jun 1972).

From third L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

Initial experiments were performed to determine the toxicity of p-nitroacetophenone (PNAP) in contact with cultured cells. At concentrations greater than 10^{-4} M, there was a progressive inhibiting effect on cell proliferation. An estimate of the radiosensitizing effectiveness of PNAP was obtained by exposing hypoxic monolayers of hamster cells to 2310 rad of x radiation in the presence of PNAP at concentrations of 5×10^{-5} M to 10^{-3} M. It was found that the sensitizing effectiveness of PNAP increased up to a concentration of 500 μM with little increase at higher concentrations. (H.L.W.)

2687 RADIOSENSITIZATION BY PNAP OF HYPOXIC CHINESE HAMSTER CELLS. Asquith, J. C. (Mount Vernon Hospital, Northwood, Eng.). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 289-92(Jun 1972).

From third L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

Results of experiments on anoxic radiosensitization of non-

synchronous hamster cells by p-nitroacetophenone are reviewed. Discussions are presented of variations in the oxygen enhancement ratio with stages in the mitotic cycle, statistical evaluation of survival curves, and cell type and method of synchronization in relation to the oxygen enhancement ratio throughout the cell cycle. (H.L.W.)

2688 RADIOSENSITIZATION AND THE CELL CYCLE: SUMMARY OF POINTS. Adams, G. E. (Mount Vernon Hospital, Northwood, Eng.). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 293-7(Jun 1972).

From third L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

Radiosensitizers are classified into the following four groups: chemical compounds that act intracellularly; chemical compounds that react outside the cell; thymine analogues; and compounds that inhibit post-radiation repair. Reviews are presented of studies on cell cycle dependence of lethal response in sensitized cells, studies on sensitizing effects of oxygen and p-nitroacetophenone on synchronized hamster cell populations, and time scale of sensitization of hypoxic cells of Serratia marcescens using N-ethylmaleimide. (H.L.W.)

2689 GAMMA-INDUCED MUTATION TO 8-AZAGUANINE RESISTANCE IN CULTURED CHINESE HAMSTER CELLS AS A MARKER IN THE CELL CYCLE. Arlett, C. F. (Univ. of Sussex, Brighton, Eng.). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 298-302(Jun 1972).

From third L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

Hamster cells were treated with ^{60}Co gamma radiation at a dose rate of 100 rad/min, and data are presented for induction of mutation to resistance to 8-azaguanine. A biphasic or cumulative response was observed in asynchronous cells with more mutants produced per rad at higher than at lower doses. In synchronous cells, mutation was a mirror image of cell survival with enhanced mutation rates in the G_2 phase; the G_1 phase cells appeared to be less mutable than S phase cells. The data indicate that mutation, as a manifestation of radiation damage, may act as an indicator of differences in response to the various stages of the cells cycle. (H.L.W.)

2690 ACTINOMYCIN D INHIBITION OF REPAIR OF A DNA COMPLEX FROM CHINESE HAMSTER CELLS. Elkind, M. M.; Chang-liu C. (Hammersmith Hospital, London). Int. J. Radiat. Biol.; 22: No. 4, 313-24(Oct 1972).

Using the technique of velocity sedimentation in alkaline sucrose gradients, the effect of actinomycin D, acting separately and in conjunction with x radiation, was examined in respect of the damage to and repair of DNA from Chinese hamster cells. Similarly to x irradiation, high survival doses of this antibiotic resolved the DNA complex, which is initially released during alkaline lysis, giving rise to a 2×10^8 dalton species. Relative to damage leading to a resolution of the DNA complex and single-break formation by radiation, actinomycin D impeded the repair of the former but not of the latter. However, in cells treated with actinomycin D alone, repair of the complex was also suppressed, probably because of the ability of this drug to bind to DNA. It is suggested that the data point to (1) a direct action of actinomycin on DNA; (2) different forms of radiation damage, leading to complex resolution as opposed to single-break formation; and (3) an equivalence in the action of actinomycin D and x radiation relative to DNA damage. It is pointed out that equivalence in action has also been found between actinomycin D and x radiation in respect of cell killing. (auth)

2691 CORRELATION OF CHROMOSOME DAMAGE AND COLONY-FORMING ABILITY IN SYRIAN HAMSTER CELLS IN CULTURE IRRADIATED IN G_1. Grote, S. J.; Revell, S. H. Curr. Top. Radiat. Res. Quart.; 7: No. 3, 303-9(Jun 1972).

From 3rd L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

Radioinduced chromosome aberrations in single cells and colony formation of the cells were observed microscopically using a modified Petri dish. A suspension of hamster cells was placed in the dish and x radiation (150 R) was given during the G_1 phase. The mitosis of the daughter cells and development of colonies from the cells were followed for five days and results were compared with unirradiated controls. It was found that all irradiated cells divided at least once although mitosis was somewhat delayed; the reproductive capacity of the cells was markedly affected by the loss of chromosome fragments. (H.L.W.)

2692 RADIATION-INDUCED DELAYS IN MITOSIS. Whitmore, G. F. (Ontario Cancer Inst., Toronto). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 317-18(Jun 1972).

From 3rd L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

A brief review is presented of studies on radioinduced mitotic delay in mammalian cells. Discussions are presented of radioinduced synchronization of mitosis in populations of mammalian cells and age-dependent differential sensitivity to radioinduced mitotic delay. Studies on comparison of the effects of chemical inhibitors with radiation effects led to the conclusion that the radioinduced block in the G_2 phase occurs at about the same time as the last synthesis of proteins required for mitosis. (H.L.W.)

2693 LOW OXYGEN-ENHANCEMENT RATIO FOR TUMOUR-CELL SURVIVAL AS COMPARED WITH THAT FOR TUMOUR-GROWTH DELAY. McNally, N. J. (Hammersmith Hospital, London). Int. J. Radiat. Biol.; 22: No. 4, 407-10(Oct 1972).

Two methods were used to measure the survival of fibrosarcoma RIB_5 cells growing in rats after x irradiation. The first was to inject cells into young rat brains and measure the number of cells required to cause half the population to develop tumors within 90 days. The second was to measure the formation of colonies in vitro when tumor cells were plated onto a feeder layer of radiation killed cultured RIB_5 cells and incubated for 10 days. Survival curves are presented for tumor cells irradiated over a dose range 0 to 2000 rads with animals breathing air, with the tumors clamped to render them hypoxic, and with the animals breathing oxygen at a pressure of 3 atm. The oxygen enhancement ratio (OER) of the survival curves whether irradiated in vivo or in vitro was 1.8. These results are discussed in relation to a value of 3.4 obtained for tumor growth delay, (Thomlinson, R. H., and Craddock, E. A., Br. J. Cancer, 21, 108 (1967)), and other literature discussing differences in response measured, according to the assay method, and models of cellular radiation damage. (UK)

2694 INHIBITION OF REPAIR OF DNA SINGLE STRAND BREAKS IN MOUSE LEUKEMIA CELLS BY ACTINOMYCIN D. Lee, Y. C.; Bennett, L. R.; Byfield, J. E. (Univ. of California, Los Angeles). Biochem. Biophys. Res. Commun.; 49: No. 3, 758-65(1 Nov 1972).

The effects of Actinomycin D, cytosine arabinoside, and temperature shifts on the repair of single strand breaks produced in murine leukemia cell DNA by ionizing radiation were studied. A recently introduced modification of the alkaline sucrose sedimentation methods was used, allowing breaks to be demonstrated following clinical range irradiation doses. The results contrast to previous data using standard gradient procedures and indicate that low concentrations of Actinomycin D can inhibit single strand break repair, while cytosine arabinoside is ineffective. Inhibition can also be demonstrated by temperature shifts to 3° but not 24°, paralleling previous results from cellular repair studies (Elkind-Sutton repair). The results are consistent with the hypothesis that the accumulation of sublethal radiation damage in mammalian cells may be based on residual non-repaired single strand breaks. (auth)

2695 ULTRAVIOLET LIGHT DAMAGE AND RECOVERY IN CULTURED MAMMALIAN CELLS. Domon, Masaharu (Tokyo Medical and Dental Univ.). Tanpakushitsu Kakusan Koso; 17: No. 3, 203-10(Mar 1972). (In Japanese).

L cells were used in studies on effects of ultraviolet light on the cell cycle and recovery. The most sensitive parameter was mitotic delay during the S phase of the cell cycle. The following methods were used for measuring the delay: synchronization of colonies using FUdR; autoradiography of cells labeled with ^{3}HTdR; and inactivation of colony formation. Effects of caffeine and inhibition of colony-forming ability during the S phase were studied in relation to detection of uv damage. Recovery from uv damage was discussed in relation to mitotic delay and inactivation of colony-forming ability. A discussion was presented of the hypothesis that DNA was the target of low-dose uv radiation in relation to recovery of L cells during the S phase. (Japan)

2696 RELATION BETWEEN DIVISION DELAY AND DAMAGE EXPRESSED IN LATER GENERATIONS. Trott, K. R. (Gesellschaft fuer Strahlenforschung, Nuremberg). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 336-7(Jun 1972).

From 3rd L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

Mouse L-cells were followed by time-lapse cinematography and pedigrees were constructed. Graphs are presented to show generation-time distribution of first generation daughters of x-

irradiated L-cells grouped according to whether one or both of the second-generation daughters continued to divide. It was found that generation times were shorter in cells both of whose daughters continued to divide than in cells one of whose daughters failed to divide again. (H.L.W.)

2697 MITOTIC DELAY IN SYRIAN HAMSTER CELLS IN RELATION TO CHROMOSOME ABERRATIONS. Grote, S. J.; Revell, S. H. Curr. Top. Radiat. Res. Quart.; 7: No. 3, 334-5 (Jun 1972).

From 3rd L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

Direct observations were made of x-radioinduced mitotic delay in cultured hamster cells and chromosome aberrations were recorded. Cell populations were divided into those that contained aberrations and those that did not. It was then determined whether or not aberration content was correlated with mitotic delay and results are presented by means of graphs. Observations suggested that aberration content was not related to mitotic delay. (H.L.W.)

2698 SENSITIVITY TO MITOTIC DELAY AND STAGE IN THE CYCLE. Sinclair, W. K. (Argonne National Lab., Ill.). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 323-7(Jun 1972).

From 3rd L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

A discussion is presented of two factors responsible for radioinduced mitotic delay in hamster cells: S-cell retention for G_2 block. A review of the literature is presented on the following topics: synthesis of RNA and protein in synchronized irradiated hamster cells; inhibitory effects of x radiation, cycloheximide, and puromycin on protein synthesis in cultured cells; and gamma-radioinduced delay in G_1 and G_2 phases of excised pea-root system cells. (H.L.W.)

2699 KINETICS OF CULTURED MAMMALIAN CELLS IRRADIATED WITH X RAYS AND NEUTRONS: STUDIES WITH TIME LAPSE CINEMATOGRAPHY. Okumura, Y. (Aichi Cancer Center, Nagoya, Japan); Onozawa, M.; Sasaki, H. Nippon Igaku Hoshasen Gakkai Zasshi; 31: No. 12, 1286-91(Mar 1972). (In Japanese).

A comparative study of kinetics of HeLa S3 cells irradiated with x rays and fast neutrons was performed with time lapse cinematography. Maximum division delay after irradiation with x rays was observed when the cells were irradiated at late S and G2 phases, and was minimum at early G1 phase. The delay caused by neutrons was unchanged through cell cycle. The cell cycle time of the irradiated generation was increased and was decreased in the successive generations for both x rays and neutrons. The dependence of cell age at irradiation on the time of cell death was examined. The cells irradiated with x rays at G1 and G2 phases survived longer than those at S phase. Less age dependence was observed with neutrons. (Japan)

2700 INDUCTION OF VIRUS SYNTHESIS IN POLYOMA-TRANSFORMED CELLS BY DNA ANTIMETABOLITES AND BY IRRADIATION AFTER PRETREATMENT WITH 5-BROMODEOXYURIDINE. Fogel, Marian (Weizmann Inst. of Science, Rehovoth, Israel). Virology; 49: No. 1, 12-22(Jul 1972).

Polyoma-virus (PV)-transformed rat cells which exhibited a spontaneous induction rate of about 1×10^{-4} cells for polyoma viral capsid (V) antigen synthesis, producing 100 plaque-forming units (PFU) per induced cell, were shown to be inducible for PV synthesis by various DNA antimetabolites. Mitomycin C (MC), nitrogen mustard (NH2), and N-nitrosomethylurea (NMU) induced 43, 24, and 9% of cells, respectively, for V antigen synthesis. The yields of infectious virus in the treated cultures were increased by a factor of up to 5×10^2, as compared to untreated cultures. The inducibility of the cells by MC, NH2, and NMU was shown to be dose-dependent increasing with the concentration of the inducing compounds to a maximum which varied for each inducer. Among the induced cells, some did not produce infectious virus, but produced V antigen; in the cultures which exhibited maximum cell inducibility for V antigen synthesis, only about 38–47% of the V antigen-containing cells produced virus. The synthesis of V antigen and of infectious virus was shown to occur in cells irreversibly blocked for cell division by the inducing agents. Bromodeoxyuridine, iododeoxyuridine, and fluorodeoxyuridine induced V antigen production in 0.8–1.4% cells, the induced cells yielding an average of 12–50 PFU per cell. Pretreatment of the cells with bromodeoxyuridine increased the inducibility of the cells for V antigen production by uv and x-irradiation, by factors of up to 10 and 15, respectively, and for infectious virus synthesis by factors of up to 5 and 6, respectively. The results suggest that the cellular DNA is the target for induction of virus synthesis in these cells and that damage of the cellular DNA results in activation of the virus genome. (auth)

2701 EFFECTS OF IONIZING RADIATION ON THE REAGGREGATION OF EMBRYONIC MOUSE BRAIN CELLS. Leith, J. T.; Schilling, W. A. (Univ. of California, Berkeley). Int. J. Radiat. Biol.; 22: No. 4, 389-94(Oct 1972).

A study was made of the effect of γ radiation on the ability of dissociated embryonic mouse brain cells to form aggregates in vitro. Irradiation was from a 1500 Ci ^{60}Co γ source at dose rates of 100 R/min over a dose range 0 to 100 R. Dose-response curves are presented in terms of percentage recovery or originally seeded cells in formed aggregates at 40 days in cell suspension culture after irradiation. There appeared to be a dose dependence on the damage to the reaggregation process. (auth)

2702 BIOLOGICAL PROTECTION MECHANISMS OF RADIOPROTECTORS IN MAMMALIAN CELLS. 16. EFFECTS OF AET ON THE EARLY INCORPORATION OF TRITIATED THYMIDINE INTO DNA AND DEATH OF EHRLICH CELLS AFTER IRRADIATION WITH ULTRAVIOLET LIGHT. Kobayashi, J.; Kawamura, F. (Tokushima Univ., Japan). Tokushima J. Exp. Med.; 18: 15-20(Oct 1971).

Unscheduled DNA synthesis of Ehrlich tumor cells in vitro was studied by measuring ^3H-thymidine(TdR) incorporation after ultraviolet light (uv) irradiation. The effects of AET on unscheduled DNA synthesis and cell death, measured by counting cells stained with eosin, were studied to examine the relation between repair replication and the action of AET. Unscheduled DNA synthesis corresponding to repair replication occurred in cells irradiated with uv. AET markedly depressed unscheduled DNA synthesis. The protective effect of AET was clear from 4 to 5 hours after irradiation but death during the first 3 hours after irradiation was similar with and without AET. (auth)

2703 RADIOSENSITIVITY OF MAMMALIAN CELLS. 6. AGE RESPONSE OF L-CELLS TO IRRADIATION ANALYZED BY MICROCINEMATOGRAPHY. Kobayashi, J.; Sako, M.; Takagi, T.; Nishikawa, H. (Tokushima Univ., Japan). Tokushima J. Exp. Med.; 18: 29-32(Oct 1971).

Studies were made on the times of the first generations after irradiation of L-cells, irradiated at different stages in the cell cycle using time-lapse microcinematography. The data show that at least six types of response of mammalian cells to radiation are dependent on the age of cell or their stage in the cell cycle at the time of irradiation. These include cell survival, production of chromosome aberrations, inhibition of DNA synthesis, mitotic delay, the extent to which cells attempt the first division after irradiation and the duration of the first cell cycle after irradiation. The dependence of the response on the age or stage of cells in the cell cycle is not the same in all cases. Differences in the rate of movement of cells through the intermitotic cycle may not be the only source of difficulty in interpreting the results of experiments with synchronized cell populations. The times of the generation cycle of individual L-cells grown in a culture vary, but the average for the whole cell population is constant under constant conditions. L-cells have generation times between 18 and 30 hours and the coefficient of variation is in the order of 12 per cent. From the present results the M and G_1 periods in the cell cycle of L-cells appear to be the most sensitive, the G_2 period is quite resistant and the S period intermediate in sensitivity to irradiation. (Japan)

2704 RELATIONSHIP BETWEEN RECOVERY OF CELL SURFACE CHARGE AND COLONY-FORMING ABILITY FOLLOWING RADIATION DAMAGE IN THREE CELL LINES. Sato, C.; Kojima, K.; Onozawa, M.; Matsuzawa, T. (Aichi Cancer Center Research Inst., Nagoya, Japan). Int. J. Radiat. Biol.; 22: No. 5, 479-88(Nov 1972).

Alterations in the negative surface charge after x-irradiation were investigated by cell electrophoresis in three different radiosensitive cell lines: Burkitt lymphoma cells P3HR-1 (extrapolation number (n) = 1, D_0 = 67 R), mouse mammary carcinoma cells FM3A (D_0 = 150 R, n = 2.5), and mouse melanoma cells B16-C2W (D_0 = 160 R, n = 20). The electrophoretic mobility decreased with time after irradiation and reached a minimum 4 hr after exposure. The relationship between the decrease in mobility during 4 hr and the radiation dose was the same in three cell lines and consisted of two straight lines. In Burkitt lymphoma cells, the decrease in mobility was irreversible, whereas the negative surface charge recovered after irradiation with 50 R in FM3A, and with doses up to 500 R in C2W. The surviving fractions (colony-forming ability) and the fractions of electrophoretically-recovered cells during 24 hr after exposure showed good correlation for five dose-points in C2W. (auth)

2705 CHROMOSOME ABERRATIONS INDUCED IN VITRO BY LOW LET RADIATIONS IN HUMAN BLOOD CELLS. PART II.

Feremans, Willy (Centre P. Cogniaux, Brussels). J. Belge Radiol.; 55: No. 3, 365-82(1972). (In French).

Human blood cells in cultures were treated with demecolcine and spontaneous aberrations were tabulated. A dose-effect curve was established following administration of electrons from the betatron functioning at 35 MeV and numbers and types of aberrations were recorded. Results are discussed under the following headings: number of aberrations per cell; radiolesions from one and two particles; number of breaks per cell; repair of cellular lesions; and chromosome and chromatid lesions. A study was made of the role of flux using 200 and 400 rad doses of electrons. The fluxes used were 10 rads/min, 50 rads/min, 100 rads/min, 250 rads/min, and 450 rads/min. Results are discussed with regard to coefficient of aberration production from one and two particles, duration of irradiation, and chromosome and chromatid aberrations. Comparisons were made of the effects of radiations as a function of their nature and wavelength. A study was made of the comparative efficiency of 20 and 35 MeV electrons and 35 MeV photons and results are tabulated. (H.L.W.)

Radiation Effects on Microorganisms

Refer also to abstracts 2671 and 2764.

2706 (AEC-tr-7362, pp 162-9) ANALYSIS OF THE RADIOBIOLOGICAL REACTIONS OF YEAST CELLS. 1. SURVIVAL CURVES AND DELAYED APPEARANCE OF MACROCOLONIES. Kapul'tsevich, Yu. G.; Korogodin, V. I.; Petin, V. G. (Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 12: No. 2, 267-71(1972).

The work was conducted in order to determine the applicability of the concepts based on the hit and target principles to the description of various forms of manifestations of radiation damage to cells. A quantitative study was made of the effect of delayed appearance of macrocolonies in haploid yeast Saccharomyces cerevisiae, 2PG-78, possessing an exponential survival curve and incapable of recovery when exposed in water, in the diploid yeast Saccharomyces cerevisiae Y0 2022D and Saccharomyces ellipsoideus Megri 139-V, possessing a sigmoid survival curve and capable of recovery, as well as among the diploid yeast Saccharomyces ellipsoideus 39-2, possessing a sigmoid survival curve but incapable of recovery. It was shown that the effect of delayed appearance of macrocolonies may be due to the delayed formation of colonies from cells that sustained a subcritical number of damages during irradiation. (tr-auth)

2707 (COO-3482-1) RADIATION REPAIR IN ENERGY-DEFICIENT YEAST MUTANTS. Parker, J. H.; Bruce, A. K. (State Univ. of New York, Buffalo. Dept. of Biology). 7 May 1971. Contract AT(11-1)-3482. 9p. (CONF-710508-5). Dep. NTIS.

From 19th annual meeting of the Radiation Research Society; Boston, Mass. (9 May 1971).

Initial damage to the DNA of irradiated cells is about equal, survival being determined by subsequent events involving the ability of a particular strain or species to repair the initial damage. Such repair systems require the expenditure of energy. Whether energy production is a limiting process in such repair is not known. To establish such a relationship, a group of yeast mutants possessing various defined lesions in mitochondrial energy metabolism were employed to study this requirement. Several wild-type and mutant strains derived from them were grown to equivalent portions of their growth curves, starved, and their dosage-survival relationships to 250 KVCP x rays determined using a complete plating medium. Several of the mutant strains are significantly more sensitive than the normal strains from which they were derived; the response of a cytoplasmic petite (possessing essentially non-functional mitochondria) being 2.9-times more sensitive than its parent. This does not appear to be a sensitization due to a decrease in growth rate since higher survival generally results from plating on minimal medium or by incubation at reduced temperature. The response to radiation may be correlated with the biochemical lesions in the energy metabolism systems of these mutants. (auth)

2708 (COO-3482-4) EFFECTS OF CHLORAMPHENICOL ON RADIATION REPAIR IN YEAST. Parker, J. H.; Bruce, A. K. (State Univ. of New York, Buffalo. Dept. of Biology). 10 May 1972. Contract AT(11-1)-3482. 11p. (CONF-720530-7). Dep. NTIS.

From twentieth annual meeting of the Radiation Research Society; Portland, OR. (14 May 1972).

Previous experiments have shown evidence of a direct relationship between radiation sensitivity and oxidative energy metabolism. In particular, yeast mutants defective in respiration were shown to be generally more sensitive to x-ray damage than normal cells. To further establish whether decreased mitochondrial function was responsible for this apparent sensitization, normal cells were grown in the presence of chloramphenicol, a known inhibitor of mitochondrial development. Both normal and mutant cells were subjected to this treatment. In general, there was at least a 50% decrease in respiratory activity in cells grown and starved in the presence of chloramphenicol (2 mg/ml). This concentration of chloramphenicol is known to be sufficient to inhibit development of respiration, but it does not affect cytoplasmic protein synthesis. When the treated cells were subjected to varying doses of 250 KVCP x-rays, it was found that they showed a concomitant increase in radiation sensitivity. These experiments further suggest a relationship between mitochondrial function and radiation repair processes. (auth)

2709 (KURRI-TR-87, pp 10-15) TARGET THEORY FOR MUTATION INDUCED BY RADIATION. Kondo, Sohei. 1971. (In Japanese).

In alteration factors of radiation injury.

A biophysical target theory is proposed for killing and mutation by taking into account repair capacity of the living cell: $S = 1 - (1 - e^{-\lambda D})^a$; $F = (\mu_D)^b$ and $\lambda = V_k d_k (1 - r_k) f_k$; $\mu = V_m d_m (1 - r_m) f_m$ where V is the actual target size of DNA or gene, d the density of primary lesions per unit dose, r the reparable fraction, f probability of occurrence of biological event to convert a lesion to killing or mutation. For uv effect, d is known as efficiency of pyrimidine dimer formation, and both r and f can be varied by using different types of repairless mutants of microorganisms. Using Escherichia coli strains, we obtained empirical formulae of the survival S vs. dose D or mutation frequency F vs. D and the r, f and $V_m f_m$ values were estimated. Similarly, x ray data were analyzed under some assumptions. This theory leads to the conclusion that mutations induced by radiation in higher forms are mostly of deletion type. (auth)

2710 (ORO-4024-3) EFFECT OF RADIATION-SENSITIVE MUTATIONS AND RADIATION ON RECOMBINATION IN PARTIALLY DIPLOID DERIVATIVES OF ESCHERICHIA COLI. Progress Report. Knudson, A. G. Jr. (Texas Univ., Houston. Graduate School of Biomedical Sciences). 28 Oct 1972. Contract AT(40-1)-4024. 4p. Dep. NTIS.

Progress is reported on the following research projects: gene sequence of the histidine operon in Escherichia coli and Salmonella typhimurium; recombination frequencies in partially diploid Escherichia coli; effects of uv sensitive mutations on excision of uv-induced thymine dimers; effects of uv and ionizing radiation on reciprocal nature of recombination in E. coli; and induction of mutations in E. coli affecting the electrophoretic mobility of enzymes. (H.L.W.)

2711 INFLUENCE OF PREPARATION TECHNIQUE, HUMIDITY, AND IRRADIATION CONDITIONS ON RADIATION INACTIVATION OF STREPTOCOCCUS FAECIUM, STRAIN A21. Emborg, C. (Danish Atomic Energy Commission, Risoe). Acta Pathol. Microbiol. Scand., Sect. B; 80: No. 3, 367-72(1972).

Cobalt-60 gamma radiation has a greater inactivating effect on dried preparations of Streptococcus faecium, strain $A_2 1$, than electron radiation from a 10 MeV linear accelerator. The difference in effect varies with relative humidity and preparation technique. The difference is 10 to 20% when the bacteria are dried with serum broth at 10 to 50% relative humidity. The radiation resistance under these conditions corresponds to the resistance of standard preparations of this strain for control of microbiological efficiency of radiation sterilization plants. Increase of the relative humidity to 55% leads to a significant drop in radiation resistance, and a doubling of the difference in effect between gamma irradiation and electron irradiation. The response of cleaned preparations is less dependent on relative humidity and very similar to the response observed at high humidity in preparations with serum broth. No difference in the effect of the two irradiation sources is observed when the bacteria are irradiated in aqueous suspension or suspended in serum broth. (auth)

2712 INCREASING NISIN PRODUCTION BY IRRADIATING STREPTOCOCCUS LACTIS CULTURES. Hylmar, B.; Teply, M.; Tesarkova, H. (Inst. of Dairy Research, Prague). Prum. Potravin; 21: No. 6, 186-90(Jun 1970). (In Czech).

Streptococcus lactis strains were uv- and gamma-irradiated with the aim of increasing nisin production. By gamma irradiation with a dose of 30,000 rads and by uv irradiation at 253.7 nm with 420.3 $\mu W/cm^3$ for 10 to 20 seconds, Streptococcus lactis mutants were obtained with an increased nisin production ability. This increased ability to produce nisin was observed after repeated and combined gamma- and uv-irradiation. Data are also given on the effect of various types of culture media on the production ability of the mutants. (NSA of Czech.)

2713 SYNTHESIS OF DNA BY MEMBRANE-DNA COMPLEXES FROM E. COLI B/r AND B_{s-1} AFTER EXPOSURE TO FAST ELECTRONS AND NEUTRONS: THE MEASUREMENT OF OXYGEN-ENHANCEMENT RATIOS AND RBE VALUES. Cramp, W. A.; Watkins, D. K.; Collins, J. (Hammersmith Hospital, London). Int. J. Radiat. Biol.; 22: No. 4, 379-87 (Oct 1972).

Irradiation of Escherichia coli B/r and B_{s-1} depressed the DNA synthetic activity of the DNA-membrane complexes from these bacteria over a range of 0 to 80 Krads. The depression of this activity in both strains in the presence of oxygen was seven to eight times greater than under anoxic conditions when irradiation was with fast electrons. The oxygen-enhancement ratios for neutrons were 4.0 and 5.2 for E. coli B/r and E. coli B_{s-1}, respectively. The DNA-synthesizing abilities of complexes from the radiation-resistant E. coli B/r and the radiation-sensitive E. coli B_{s-1} were equally inhibited by electron irradiation, but with fast neutrons the synthetic activity of the DNA-membrane complex from E. coli B/r was more inhibited than that from E. coli B_{s-1}. (auth)

2714 INVOLVEMENT OF THE EXCISION REPAIR SYSTEM IN RECOVERY OF BACTERIOPHAGE FROM γ-RAY DAMAGE SUSTAINED UNDER OXIC AND ANOXIC CONDITIONS. Bleichrodt, J. F.; Verheij, W. S. D.; De Jong, J. (TNO, Rijswijk, Netherlands). Int. J. Radiat. Biol.; 22: No. 4, 325-35(Oct 1972).

Bacteriophages T1 and λ irradiated with gamma rays under anoxic conditions showed a higher survival when assayed on an Escherichia coli Hcr^+ strain than when assayed on a Hcr^- derivative (uvr A, B or C). Hardly any difference in sensitivity was seen for phage irradiated in the presence of oxygen. Assayed on a strain deficient in DNA polymerase I, the survival of irradiated T1 was lower than on the wild-type parent, for irradiation under both oxic and anoxic conditions. It is concluded that the damage sustained under oxic conditions, which is repaired by the excision repair system, does not need the products coded by the uvr genes, whereas part of the damage inflicted under nitrogen does. This conclusion is supported by the observation that the sensitivities of bacteriophages T4D and $T4Dv_1$ for γ rays differ under nitrogen, but are identical under oxygen. (auth)

2715 RADIOSENSITIZATION OF ANOXIC CELLS OF E. COLI K-12 BY ORGANIC NITROXYL FREE RADICALS. Brustad, T. (Norsk Hydro's Inst. for Cancer Research, Oslo). Int. J. Radiat. Biol.; 22: No. 5, 443-56(Nov 1972).

Radiosensitization of anoxic, log-phase cells of Escherichia coli K-12, strain AB 2463 roc^-A, by organic nitroxyl free radicals (TMPN and TAN) was studied by means of two kinds of rapid-mixing equipment. For the sensitizer concentrations used (10^{-3}M) the nitroxyl-mediated radiosensitization was shown to be nearly independent of the dose/rate from 20 rads/sec to 8×10^3 rads/sec. Insignificant sensitization was observed when cells were irradiated, and at various times afterwards mixed with an unirradiated solution of nitroxyls. The time course of the nitroxyl-mediated radiosensitization resulting from irradiation performed at given times after mixing of the cell suspension with the nitroxyl solution was determined. It was suggested that three processes are involved: a very rapid one, perhaps associated with membrane transients, which for 10^{-3} sec $< t < 10^{-1}$ sec provides a small sensitization (about 30% increase), an intermediate process, perhaps governed by diffusion of nitroxyls into the cells. Within about 5 sec this process increases the radiosensitivity by a factor of 3 relative to that of anoxic cells in the absence of nitroxyls, a slow process, which, in addition to diffusion, may reflect reactions of nitroxyls with (unirradiated) cellular constituents, among which endogenous sulphydryls may be involved. This process requires times of several minutes for completion. (auth)

2716 GENETICALLY CONTROLLED REMOVAL OF SPORE PHOTOPRODUCT FROM DEOXYRIBONUCLEIC ACID OF ULTRAVIOLET-IRRADIATED BACILLUS SUBTILIS SPORES. Munakata, Nobuo; Rupert, C. S. (Univ. of Texas, Dallas). J. Bacteriol.; 111: No. 1, 192-8(Jul 1972).

Previous genetic analysis indicated that at least two genes determine the ultraviolet (uv) sensitivity of Bacillus subtilis spores. The present study shows that these genes independently control two distinguishable processes for removing uv-induced spore photoproduct (5-thyminyl-5,6-dihydrothymine, or TDHT) from spore deoxyribonucleic acid. The first is a spore repair mechanism by which TDHT is removed rapidly without appearing in acid-soluble form. This mechanism, which is demonstrated in both uv-resistant and excision-deficient strains, operates to a certain extent during germination without requiring vegetative growth. The second, demonstrated in a mutant which lacks the first mechanism, removes TDHT relatively slowly and only if germinated spores are allowed to develop toward vegetative cells. The latter mechanism appears identical to excision-resynthesis repair, since the mutation abolishing it renders the irradiated vegetative cells incapable of removing cyclobutane-type pyrimidine dimers. Blocking either one of these mechanisms only slightly affects the uv sensitivity of spores, but blocking both prevents TDHT removal and gives high uv sensitivity. (auth)

2717 REQUIREMENT FOR PROTEIN SYNTHESIS IN REC-DEPENDENT REPAIR OF DEOXYRIBONUCLEIC ACID IN ESCHERICHIA COLI AFTER ULTRAVIOLET OR X IRRADIATION. Ganesan, A. K.; Smith, K. C. (Stanford Univ., Calif.). J. Bacteriol.; 111: No. 2, 575-85(Aug 1972).

Deprivation of amino acids required for growth or treatment with chloramphenicol or puromycin after irradiation reduced the survival of Rec^+ cells of Escherichia coli K-12 that were exposed to either ultraviolet (uv) or x radiation. In contrast, these treatments caused little or no reduction in the survival of irradiated recA or recB mutants. The effect of chloramphenicol on the survival of x-irradiated cells was correlated with an inhibition of repair of single-strand breaks in irradiated deoxyribonucleic acid (DNA), previously shown to be controlled by recA and recB. In uv-irradiated cells, no effect of chloramphenicol was detected on the repair of single-strand discontinuities in DNA replicated from uv-damaged templates, a process controlled by recA but not by recB. From this we concluded that inhibiting protein synthesis in uv or x-irradiated cells may interfere with some biochemical step in repair dependent upon the recB gene. When irradiated Rec^+ cells were cultured for a sufficient period of time in minimal growth medium before chloramphenicol treatment their survival was no longer decreased by the drug. After x irradiation, this occurred in less than one generation time of the unirradiated control cells. After uv irradiation, it occurred more slowly and was only complete after several generation times of the unirradiated controls. These observations indicated that replication of the entire irradiated genome was probably not required for rec-dependent repair of x-irradiated cells, although it might be required for rec-dependent repair of uv-irradiated cells. (auth)

2718 DEATH THROUGH RESPIRATORY FAILURE OF A FRACTION OF ULTRAVIOLET-IRRADIATED ESCHERICHIA COLI B/r CELLS. Swenson, P. A.; Schenley, R. L. (Oak Ridge National Lab., Tenn.). J. Bacteriol.; 111: No. 3, 658-63(Sep 1972).

Escherichia coli B/r cells grown on a glycerol-containing medium and ultraviolet (uv)-irradiated to about 0.5% survival respire for about 1 hr and then cease for several hrs. The cells that have completed repair and recovery processes begin to divide about 120 min after uv treatment, but this division is completely inhibited in liquid medium by caffeine, which delays repair of the irradiated deoxyribonucleic acid (DNA). When 5-fluorouracil (FU) is used to maintain respiration, the number of cells that form colonies when plated increases about 60-fold within 1 hr after irradiation. At least part of this increase does not involve repair while the cells are in the liquid medium because when caffeine is present there is still a 20-fold increase in colony formation. We conclude that many irradiated cells, although capable of carrying out complete and accurate repair of their DNA, die of respiratory failure; only when continuance of respiration is favored by FU treatment is their colony-forming potential realized. After an early increase, the number of cells able to form colonies in medium that contains FU remains constant while the completion of repair and recovery occurs. After these processes are completed, the number of cells able to form colonies increases slowly, except in the presence of caffeine, presumably because the late increase requires that repair steps take place while the cells are in liquid medium prior to cell division. (auth)

2719 REPAIR OF ULTRAVIOLET LIGHT-INDUCED DAMAGE TO THE DEOXYRIBONUCLEIC ACID OF NEUROSPORA CRASSA. Worthy, T. E.; Epler, J. L. (Univ. of Tennessee, Knoxville). J. Bacteriol.; 110: No. 3, 1010-16(Jun 1972).

A method is described for labeling a specific pyrimidine in the deoxyribonucleic acid (DNA) of Neurospora crassa. In cells grown in the presence of [5-^{3}H]-uridine, more than 97% of the radioactivity associated with the DNA was incorporated into cytosine. The specific activity of the labeled DNA was approximately 3×10^3 counts per min per μg. The DNA was isolated by elution from hydroxyapatite columns with sodium phosphate buffer (0.40 M, pH 6.8). This procedure was used to demonstrate that in vegetative cells of N. crassa both photoreactivation and excision repair are operative, as measured by the removal of ultraviolet light-induced cytosine-containing dimers. (auth)

2720 POSTREPLICATION REPAIR OF ULTRAVIOLET DAMAGE IN HAEMOPHILUS INFLUENZAE. Leclerc, J. E.;

Setlow, J. K. (Univ. of Tennessee, Oak Ridge). J. Bacteriol.; 110: No. 3, 930-4(Jun 1972).

The deoxyribonucleic acid (DNA) synthesized following ultraviolet (uv) irradiation of wild-type (Rd) and recombination-defective strains of Haemophilus influenzae was analyzed by alkaline sucrose gradient sedimentation. Strain Rd and a uv-resistant, recombination-defective strain Rd(DB117)$^{rec^-}$ are able to carry out postreplication repair, i.e., close the single-strand gaps in the newly synthesized DNA; in the uv-sensitive, recombination-defective strain DB117, the gaps remain open. The lack of postreplication repair in this strain may be the result of degradation of the newly synthesized DNA. (auth)

2721 PROTECTION OF (BACTERIA) NORMAL, LYSOGENIC, AND PYOCINOGENIC STRAINS AGAINST ULTRAVIOLET RADIATION BY BOUND ACRIFLAVINE. Alper, T.; Forage, A. J.; Hodgkins, B. (Hammersmith Hospital, London). J. Bacteriol.; 110: No. 3, 823-30(Jun 1972).

The presence of bound acriflavine protects bacteria against the lethal effects of ultraviolet (uv) light, presumably because pyrimidine dimer formation is inhibited. Although acriflavine present in plating medium usually results in reduced viable counts from irradiated bacteria, no enhancement of lethal effects is observed when acriflavine is added to irradiated bacteria left in suspending buffer for 45 min before plating. Acriflavine remaining bound to the DNA of irradiated bacteria at the time they are plated likewise does not affect their survival. Protection is precisely dose-modifying unless some killing of bacteria by uv results from induction of prophage, against which bound acriflavine is less protective, or from induction of pyocin, against which there is no protection at all. It is inferred that prophage induction proceeds in part, and pyocin induction wholly, by virtue of effects of uv other than pyrimidine dimerization. The response of Escherichia coli strain B to radiation was postulated to be attributable in part to induction of a prophage or a lethal protein; but exact dose modification was observed for this strain, to about the same extent, whether or not the irradiated organisms were grown in conditions thought to enhance the expected contribution to killing if such a mechanism were involved. Our results support the hypothesis that the inhibition by acriflavine of dimer formation is attributable to energy transfer mechanisms. They fail to support the hypothesis that shapes of survival curves (in particular the manifestation of "shoulders") can be attributed to inactivation by radiation of repair enzymes. (auth)

2722 YIELD OF X-RAY-INDUCED DNA SINGLE-STRAND BREAKS IN NIACIN-STARVED E. COLI K-12. Town, C. D.; Smith, K. C.; Kaplan, H. S. (Stanford Univ., Calif.). Int. J. Radiat. Biol.; 22: No. 5, 513-16(Nov 1972).

The effect of niacin starvation on growth and sensitivity of Escherichia coli K-12 was studied over an x-ray dose range of 0 to 30 Krad. The period of starvation studied ranged from 0 to 400 min. The results demonstrated that there was a 1.9-fold increase in the yield of DNA single-strand breaks in niacin-starved cells irradiated in the absence of oxygen, as compared with polA1 cells irradiated under the same conditions. The yield of breaks in aerobically irradiated niacin starved cells was increased 1.2-fold. No rejoining of single-strand breaks was seen when niacin or nicotinamide adenine dinucleotide (NAD) was added back to anoxically irradiated cells. It is suggested that as niacin starvation has been shown to reduce ligase activity in these cells, the results support the theory that DNA ligase is involved in an ultrafast repair system. (UK)

2723 DNA REPAIR OF RADIATION DAMAGE IN PLASMID-CONTAINING MINICELLS OF ESCHERICHIA COLI. Paterson, M. C. Knoxville, Tenn.; Univ. of Tennessee (1972). 117p. University Microfilms Order No. 72-27,492.

Thesis.

Minicells, devoid of chromosomal deoxyribonucleic acid (DNA), are formed by misplaced cell fissions near the polar extremities of an Escherichia coli K-12 mutant strain. Plasmid DNA [i.e., drug resistance (R) factor or λdv macromolecules] in the form of superhelical covalently closed circles may be introduced into minicells by segregation from a plasmid [i.e., R64-11 or λdv DNA]-containing derivative of the original mutant. R^+ minicells have been examined for their ability to correct defects produced in their plasmid DNA by ultraviolet (uv) and γ radiations. Minicells harboring R64-11 DNA, in comparison with their repair-proficient minicell-producing parents, possess an equal competence to rejoin single-strand breaks induced in DNA by γ rays, a reduced capacity for the photoenzymatic repair of uv-induced pyrimidine dimers, and a total inability to excise dimers, apparently due to a deficiency in uv-specific endonuclease activity responsible for mediating the initial incision step in excision repair. Assuming that the DNA repair properties of R^+ minicells reflect the concentration of repair enzymes located in the plasmid-containing polar caps of entire cells, the findings suggest that: the enzymes responsible for rejoining single-strand breaks are distributed throughout the cell. Photoreactivating enzyme molecules tend to be concentrated near bacterial DNA and to a lesser extent near plasmid DNA. UV-specific endonuclease molecules are primarily confined to the central region of the E. coli cell and, thus, seldom segregate with R factor DNA into minicells. (Diss Abstr. Int., B)

2724 INTERFERON PRODUCTION AND OTHER PROPERTIES OF PARTIALLY INACTIVATED INFLUENZA VIRUS. Orlova, T. G.; Eremkina, E. I. (Inst. of Epidemiology and Microbiology, Moscow). Acta Virol. (Prague) Engl. Ed.; 15: No. 2, 126-32(Mar 1971).

Ultraviolet- (uv-) and gamma-irradiation of influenza virus caused a gradual and stepwise loss of the ability of viral RNA to form virus-specific components in the cells. The formation of viral infectious progeny proved to be the most sensitive function, followed by the ability to produce haemagglutinin. The ability to synthesize virus-induced actinomycin D-resistant RNA in the cells was found to be the most resistant. Such stepwise damage of viral RNA by uv- and gamma-irradiation resulted in an increased ability of the irradiated virus to induce the production of serum (in mice) and culture (in chicken embryo cells) interferon. A maximum interferon production was observed with virus still capable of inducing the synthesis of virus-specific RNA in infected cells. Heating of the virus at 56°C and treatment with beta-propiolactone (BPL) resulted in almost simultaneous inactivation of its ability to synthesize virus-specific components in the cells. The intensity of serum interferon production decreased with proceeding inactivation, but heat-inactivated virus unable to synthesize virus-specific components caused an increased production of interferon in cell cultures. (NSA of Czech.)

2725 ELIMINATION OF SALMONELLA FROM FOODS AND FEEDS BY IRRADIATION. Kawashima, Koji (Food Research Inst., Tokyo). Nippon Shokuhin Kogyo Gakkaishi; 18: No. 9, 441-8(Sep 1971). (In Japanese).

Recently, the contamination rate of meat products on the market by Salmonella has become high, and especially the contamination rate of imported meat by Salmonella is extremely high, namely 15% in imported beef and 40 to 60% in horse meat. Bactericidation by irradiation is very simple in its treatment, and food can be sterilized in its original condition. Radiation resistance of the Salmonella is rather low, but it varies by its irradiating conditions. Appropriate dose may be 0.75 to 0.80 Mrad for sterilization of feed, and 0.65 Mrad for sterilization of the imported meat, while 0.4 to 0.5 Mrad may be suitable for chicken meat as its irradiation easily results in off-flavor. As for eggs, liquid whole eggs for dried egg requires 0.15 Mrad irradiation, which brings about off flavor, while 0.5 Mrad irradiation of frozen eggs causes no effect on flavor. Feeding of swine and mice with 1 Mrad irradiated feed gave no observable influence. Judging from ^{60}Co cost, it costs 200 yen per 1 Ci, which is 3.7 yen per kg for 0.65 Mrad irradiation. This is economical considering the effect of sterilization. (Japan)

2726 INACTIVATION OF STRAINS OF SALMONELLA SENFTENBERG BY GAMMA IRRADIATION. Underdal, B.; Rosseboe, L. (Veterianary Coll. of Norway, Oslo). J. Appl. Bacteriol.; 35: No. 3, 371-7(Sep 1972).

Strains of Salmonella senftenberg isolated from Norwegian herring meal and strain 775W were exposed to γ radiation from a ^{60}Co source. When they were irradiated in phosphate buffered saline solution, the average D_{10} value for all the strains was 19.3 Krad. On irradiating strains 56 and 775W in herring meal the D_{10} values were 192.1 and 188.5 Krad, respectively, thus indicating that the suspending medium had a great effect on the radiation resistance of the organisms. Radiation doses of the order of 0.8 to 1.3 Mrad were recommended for the decontamination of herring meal. (UK)

Radiation Effects on Plants

Refer also to abstracts 2668 and 2764.

2727 (AEC-tr-7362, pp 1-15) PRINCIPLES OF THE FORMATION OF RADIORACES IN YEAST ORGANISMS. Korogodin, V. I.; Bliznik, K. M. (Scientific Research Inst. of Medical Sciences, Obninsk, USSR). Translated from Radiobiologiya; 12: No. 2, 163-70(1972).

Yeasts in the stationary phase of growth were irradiated with the γ rays of ^{60}Co at a dose of 70 krad and inoculated onto agarized wort. Among the colonies that grew out, those modified in size and

shape were selected and, passaging them on solid medium, the peculiarities of the manifestation of inherited changes induced in them by irradiation were studied. About 100 radioraces, belonging to 12 morphological groups, were isolated and studied. It was found that many of these radioraces are similar to or identical with the races obtained by G. A. Nadson and his associates (1925 to 1937) in yeast organisms of different species and genera under the influence of irradiation, reduced and increased temperatures, chloroform, and other influences. The possible nature of the genetic changes lying at the basis of radiation race formation in yeasts, as well as certain general biological aspects of this phenomenon, are discussed. (tr-auth)

2728 (AEC-tr-7362, pp 133-40) STUDY OF THE CAUSES OF THE RADIORESISTANCE OF PLANTS OF THE CRUCIFERAE FAMILY. Kaplan, I. S.; Tikhomirov, F. A. (Moscow State Univ.). Translated from Radiobiologiya; 12: No. 2, 247-52(1972).

It was shown in the work that the radioresistance of species and varieties of mustard seeds is associated with their content of glucosides, which possess radioprotective properties. The irradiation of mustard seeds in M_2, irradiated or treated with chemical mutagens in M_1, permitted the isolation of radioresistant forms. Probably such radioresistance is associated with the selection of forms characterized by an increased content of mustard oils. This opens up the possibility for the selection of mustard seeds for their essential oil content. (tr-auth)

2729 (AEC-tr-7362, pp 141-50) FACTORS INFLUENCING THE MANIFESTATION OF THE OXYGEN EFFECT IN THE IRRADIATION OF DORMANT PEA SEEDS. Tsarapkin, L. S.; Tsarapkina, K. A. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 12: No. 2, 253-9(1972).

Irradiation of dormant seeds in argon and soaking of irradiated dormant seeds in water saturated with argon reduce the cytogenetic damage only on material with a low water content (3 to 7%). Breaking of the seed coats increases the radioresistance in dry material (3 to 6% water) and lowers it on moist material (14 to 18% water). The appearance of an oxygen effect on moist dormant seeds depends on the intensity of the forced removal of gases from the seeds, followed by their replacement by argon, and increases with increasing number of repeated evaluations. (tr-auth)

2730 (AEC-tr-7362, pp 151-61) RADIOSENSITIVITY OF PHASES OF THE MITOTIC CYCLE OF PLANT MERISTEMS. Gudkov, I. N.; Grodzinskii, D. M. (Inst. of Plant Physiology, Kiev, USSR). Translated from Radiobiologiya; 12: No. 2, 260-6(1972).

The effects of γ radiation at doses of 50 to 800 rad on the duration of the mitotic cycle and individual phases of it, as well as the radiosensitivity of cells at various phases of the cycle in the root meristem of pea seedlings, was studied by the method of radioautography, using ^{3}H-thymidine and synchronization of cell divisions with hydroxyurea. The duration of the cycle was already increased in the case of irradiation at a dose of 50 rad, while at a dose of 800 rad it increased from 16.5 to 22.4 hrs. Lengthening of the cycle is due chiefly to an increase in the duration of the G_1-phase, and to a lesser degree to the remaining phases. A study of the radiosensitivity of synchronously dividing cells showed that the phases of the cycle with respect to increasing sensitivity to irradiation can be arranged in the following order: early G_1, S, mitosis, G_2, and late G_1. (tr-auth)

2731 (AEC-tr-7362, pp 231-4) INFLUENCE OF PRE-PLANTING GAMMA IRRADIATION ON THE YIELD AND PHYTOPHTHOROSIS OF POTATOES. Zeimalov, I. I.; Aliev, A. A.; Riza-Zade, R. R. (Azerbaidzhan Scientific Research Inst. of Vegetable Growing, Baku, USSR). Translated from Radiobiologiya; 12: No. 2, 311-13(1972).

A stimulating γ dose (500 R) for increasing the yield of potatoes of the Lorkh variety by 50% with a sharp reduction of the vulnerability of the tops to phytophthora, was established in the three-year field experiments. An inverse relation is observed between the degree of development of phytophthora and the yield of potato tubers. (tr-auth)

2732 (CONF-721102-2) EXPLORATORY INDUCTION OF SOLID MUTATIONS IN YAMS BY GAMMA IRRADIATION. Koo, F. K. S.; Ruiz, J. C. (Puerto Rico Nuclear Center, Mayaguez). [nd]. 10p. Dep. NTIS.

From 12th international symposium on basic biology; Cali, Colombia (27 Nov 1972).

Some 700 aerial tubers of the varieties Cuello Largo, Purple Lisbon, Hawaii Branched, Brazo Fuerte, Farm Lisbon and Irene yams were each cut into two parts. The crown part served as control and the lower part was treated with 2,000 rads of γ rays. The material was grown in the soil benches in the greenhouse. The first shoots of the irradiated material at 3 to 4 leaf stage were studied for new variations by comparing with the corresponding controls. Crinkled or deformed leaves were observed more often than leaves with sectorial color changes. The shoots were then cut back above the ground to force the new shoots to develop for further observation. Some two dozen of solid mutations were observed in the new shoots following one to several cut-backs. The light green type was most frequent while the stunted type was less frequent. Also recovered, but in very low frequency, were pale green and small leaf types. These solid mutants were originated from either the tubers or the leaf axils of the pruned shoots. Also observed was that some varieties were more amenable to mutation induction than the others. Our findings appear to suggest that a number of new shoots in yam aerial tubers or leaf axils were derived from single cells after the earlier shoots were pruned. Such capacity to regenerate new shoots from single cells in the tubers or in the leaf axils following pruning at an early stage is of great importance to yam mutation breeding program. (auth)

2733 (KURRI-TR-87, pp 16-21) RELATIVE BIOLOGICAL EFFICIENCY OF 14.1 MeV FAST NEUTRON AND ^{137}Cs GAMMA RAYS IN TRADESCANTIA STAMEN HAIRS AND PRE-SOAKED TRITICUM SEEDS. Ichikawa, S. 1971. (In Japanese).

In alteration factors of radiation injury.

The relative biological efficiency of 14.1 MeV fast neutrons as compared with ^{137}Cs gamma rays was studied in the stamen hairs of Tradescantia reflexa (4x, 2n = 24)KU 7 clone which is heterozygous for flower color and also in the pre-soaked seeds of Triticum boeoticum (2x, 2n = 14) and its autotetraploid. The RBE values determined in Tradescantia stamen hairs, an essentially single-meristematic-cell system, were 3.4 to 4.0 for the loss of reproductive integrity and 4.8 to 5.3 for somatic mutation induction. The values for growth inhibition (reduction of seedling height, wet weight and dry weight) in Triticum were 3.1 to 3.5 in the diploid and 2.7 to 2.8 in the autotetraploid. These values are much lower than those usually obtained from higher plants (mostly dry seeds) and are closer to those from other organisms. It is obvious that water content modifies RBE values. (auth)

2734 (KURRI-TR-87, pp 41-7) EFFECTS OF WATER CONTENT UPON NEUTRON INDUCED DAMAGE IN HIGHER PLANTS. Fujii, Taro. 1971. (In Japanese).

In alteration factors of radiation injury.

It is well known from radiobiological experiments that the RBE of fast neutrons for higher plants is generally higher than that of fast neutrons for microorganisms or for animals; for instance, the RBE of fast neutrons with reference to somatic mutations after seed irradiations, in wheat and Arabidopsis, was found to be around 15. Such a comparison, however, should take into account the moisture content of the irradiated material which is well known to affect the extent of radiobiological damage, since the latter are generally irradiated in highly hydrated state in contrast to dry seeds. From the above, pollen grains of maize, whose moisture content is about 50%, were used and gamma-ray and neutron mutagenesis in specific genes has been examined. RBE value was estimated at the level of induction of 5% mutation, because of the difference in the shape of dose-effect-curves of both radiations. From the results, the RBE of neutrons is assessed to be about 4. Furthermore, seeds of Arabidopsis, both in the air dried state and of 24 hours of soaking in water, were irradiated with gamma-rays as well as neutrons and the extent of survival was scored as the biological end point. When the survival curves under the two radiation treatments were compared with each other, fast neutrons were nearly 15 times as effective in the dry seeds, but only 4 times as effective in the wet seeds as gamma-rays, at the LD_{50} level. Thus, the killing effect of neutrons was very high, and it appears that the effect of high LET radiations is considerably modified by the water content of the material. Although high LET radiations are considered to be less subject to have their effects modified by environmental factors, it is seen from these results that the moisture content of the biological system has a pronounced effect not only on killing efficiency and mutagenesis but also on the RBE values. (auth)

2735 M_1 CHLOROPHYLL CHIMERAS INDUCED BY DIFFERENT MUTAGENS AND THEIR M_2 CHLOROPHYLL MUTATION YIELDS IN RICE. Karunakaran, K.; Kiss, I. S. (Research Inst. for Irrigation and Rice Cultivation, Szarvas, Hungary). Biol. Plant. (Prague); 13: No. 3, 207-8(1971).

Studies with gamma rays, fast neutrons, and various EMS treatment of rice showed a higher frequency of M_1 chlorophyll chimeras after EMS treatment, a correlation between the frequency of M_1 chlorophyll chimeras and that of M_2 chlorophyll mutants, and a higher M_2 mutation frequency in the progeny of chimeric M_1 plants compared with those of normal plants. (NSA of Czech.)

2736 DARK-RECOVERY OF GAMMA- AND UV-IRRADIATED SACCHAROMYCES CARLSBERGENSIS AT 4°C. Azad, A. A.; Hannan, M. A. (Atomic Energy Centre, Dacca, Bangladesh). Mycopathol. Mycol. Appl.; 47: No. 4, 323-9(Sep 1972).

Experiments were carried out to find the effect of dark-holding in distilled water at 4°C on recovery of gamma- and uv-irradiated cells of a haploid strain of Saccharomyces carlsbergensis. It was found that there was an appreciable increase in survival of the irradiated cells following 4 to 24 hrs' holding while no increase in the number of control cells was observed following similar treatment. It is suggested that some common type of damage induced by both gamma and uv radiations in S. carlsbergensis may be repaired efficiently under metabolic conditions associated with growth at 4°C in distilled water. (auth)

2737 STUDY OF THE EFFECT OF ACUTE GAMMA IRRADIATION ON PEAR VARIETIES. Petrovic, J.; Hnidzik, F.; Dologova, O.; Krcikova, V. (Agriculture Univ., Nitra, Czech.). Pol'nohospodarstvo; 17: No. 5, 337-50(1971). (In Slovak).

The effect was studied of acute gamma irradiation on morphology and certain quantitative characteristics of the varieties Williams, Drouard, Bosco and July of winter grafts. The winter grafts of the first three varieties were irradiated with doses of 2000 R (D_1), 4000 R (D_2), and 6000 R (D_3), respectively. The July variety was irradiated with doses of 4000 R and 6000 R. In the first year, irradiation resulted in a significant change in the proportion of the length to the width of the leaf blade. In the number of deformed leaves, considerable variety differences were found. In all the varieties, an increased formation of leaf bundles was observed. Irradiation also resulted in the formation of opposite buds on the shoots. Following irradiation, the varieties responded differently to the formation of flower buds. In the Bosco variety, a dose of 4000 R stimulated the growth of the shoots. In some cases, irradiation resulted in space deformations of the terminal parts of one year's rods and the bifurcation of shoots. (NSA of Czech.)

2738 CONTROL AND MODIFICATION OF SEED RADIOSENSITIVITY. Conger, B. V. (Univ. of Tennessee, Knoxville). Trans. ASAE (Amer. Soc. Agr. Eng.); 15: No. 4, 780-4(1972).

Factors that modify the response of seeds to ionizing radiations may be grouped into two main categories, biological and environmental. The most important biological factor appears to be the volume of the nuclei in cells of the terminal apex of the dormant embryo, i.e., the larger the nucleus or target, the more radiosensitive the species. Seeds within a species may also vary several fold in radiosensitivity depending on the environmental conditions under which they are irradiated and treated postirradiation. Oxygen appears to be a major factor in the modification of x- and γ-radiation-induced damage in seeds. Other factors, such as water content, appear to be secondary; their main role being that of modifying the oxygen effect. The oxygen effect varies greatly, however, among species. The effects of fast neutrons are much less subject to modification by environmental factors. Neutrons are also considerably more effective than x or γ rays in the induction of biological damage. (auth)

2739 EFFECT OF ACUTE GAMMA IRRADIATION AT VARIOUS STAGES OF SEASONAL GROWTH IN PINUS BANKSIANA LAMBERT. Rudolph, T. D. (Dept. of Agriculture, Rhinelander, Wis.). pp 289-300 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

Three-year-old Pinus banksiana seedlings in pots were exposed to ^{137}Cs gamma rays to receive 0, 150, 300, 600, or 900 R within a 20-h period. Replicated groups of seedlings were irradiated each week during the growing season beginning in early May and ending in September. Response to irradiation at each stage of development during the growing season was evaluated on the basis of survival and shoot and needle growth. Shoot growth was measured weekly during the season of irradiation and the following year. Needle growth was measured weekly during the year of irradiation. Mortality of the terminal shoots present at the time of irradiation ranged to 98% and tree mortality to 24% in seedlings exposed to 900 R. Terminal shoot elongation was completely inhibited for the remainder of the growing season immediately after exposure to 600 and 900 R. Height growth from lateral meristems, interfoliar buds or new apical meristems gradually resumed during the following season. Needle growth was slightly inhibited by early season exposures to 300 R and was completely arrested at 600 and 900 R. Patterns of periodic shoot growth during the season one year after irradiation indicated that the seedlings varied in radiosensitivity during the course of seasonal growth. The most sensitive stage occurred at the time of shoot growth cessation and initial differentiation of the shoot primordia for the following season. (auth)

2740 STUDIES ON THE METABOLISM OF FREE AMINO ACIDS DURING MATURATION AND RIPENING OF TOMATO FRUITS. 2. CHANGES OF THE ACTIVITIES OF GLUTAMIC ACID DECARBOXYLASE AND GLUTAMIC ACID DEHYDROGENASE IN TOMATO FRUITS DURING MATURATION AND RIPENING. Yamanaka, H.; Chachin, K.; Ogata, K. (Osaka Prefectural Univ., Sakai, Japan). Engei Gakkai Zasshi; 40: No. 3, 287-91(Sep 1971). (In Japanese).

Glutamic acid decarboxylase in Fukuji No. 2 tomato fruits was easily extracted with M/15 phosphate buffer and showed the highest activity between pH 5.5 and 5.6. The decarboxylase activity was very high in immature tomato fruits and decreased during maturation. With ripening at 20°C the enzyme activity also decreased, but after 27 days in the storage at 6°C it was high. When tomato fruits were γ irradiated with 250 and 1000 Krad, the activities of the decarboxylase in irradiated fruits decreased immediately after irradiation in comparison with those in unirradiated fruits, but recovery was observed after 2 to 5 days. Glutamic acid dehydrogenase was found in tomato fruits. The activity of the dehydrogenase was higher in immature fruits than in mature ones. (auth)

2741 STUDIES ON THE RADIATION BREEDING IN THE GENUS MENTHA. 9. EFFECTIVE IRRADIATION TECHNIQUES TO INDUCE MUTATION IN MINT. Ono, Seiroku (Okayama Univ., Japan). Okayama Daigaku Nogakubu Gakujutsu Hokoku; No. 37, 9-15(Mar 1971).

The irradiation techniques to induce mutations in mint effectively were checked using chlorophyll mutants as an indicator after acute irradiation of air-dried dormant seeds, and after chronic irradiation of developing seeds and growing buds. In acute irradiation of dormant seeds, the low mutation rate and the saturation effect of the mutations at high exposure were observed showing less effectiveness of the dormant seed irradiation. In chronic irradiation of growing plants, the mutation rate per R unit was nearly constant and neither threshold exposure nor saturation effect of the mutations was observed. In irradiation of developing seeds, only limited exposure may be delivered owing to severe radiation damage; the actual number of mutants was low in comparison with those of the developing bud irradiation. For increasing the number of the mutants in the X_2 generation, irradiation of the developing buds was the most effective; irradiation of the developing seeds was less effective; and irradiation of the dormant seeds resulted in the lowest rate of mutation. (Japan)

2742 CHROMOSOMAL DAMAGES AND THE FREE RADICAL STATE IN BARLEY SEEDS AFTER A SINGLE OR FRACTIONAL IRRADIATION IN NITROGEN OR IN AIR. Nuzhdin, N. I.; Samokhvalova, N. S.; Nechaev, I. A.; Sheksheev, E. M. (Inst. of Biologogical Physics, Pushchino-Na-Oke, USSR). Dokl. Akad. Nauk SSSR; 204: No. 1, 218-21(1 Mar 1972). (In Russian).

Barley seeds were irradiated once (15 and 7.5 kR) and fractionally 7.5 + 7.5 kR with ^{137}Cs gamma rays. Irradiation and post-irradiation storage were conducted at room temperature either in an atmosphere of N_2 or air. The yield of aberrant cells in late anaphase and early telophase of the first mitosis of the root meristem was measured. Experiments in air showed that post-radiation storage of seed irradiated once resulted in a reliable number of aberrant cells. Experiments conducted in N_2 resulted in fewer aberrant cells than those in air. The effect of fractional irradiation was noticeable with only 15 min between doses; the maximum effect was manifest at an interval of 1 hr between doses. The yield of free radicals was studied: both stable and unstable types toward N_2 were detected. (K.S.W.)

2743 EFFECTIVENESS AND EFFICIENCY OF SINGLE AND COMBINED TREATMENTS WITH RADIATIONS AND ETHYL METHANE SULPHONATE IN SORGHUM. Sreeramulu, K. (Agricultural Univ., Wageningen, Netherlands). Proc. Indian Acad. Sci., Sect. B; 74: No. 3, 147-54(1971).

Effect of single treatments with x and γ rays and ethyl methane sulphonate (EMS) and combination treatments of γ rays and EMS on survival, seedling growth, and seed fertility in M_1 and chlorophyll mutation frequency in M_2 was studied in sorghum following seed treatment. There was an increase in the reduction of survival and seedling height and seed fertility with an increase in the dose of mutagens. Combined treatments were found to be more effective in reducing the survival and height of seedlings than single treatments, while EMS caused more drastic effect on seed fertility than the rest of the mutagens. The frequency of chlorophyll mutations in the M_2 increased with dose up to a certain dose level and then levelled off at high doses. EMS induced higher frequency of chlorophyll mutations than treatments with radiations. Combination

treatments were found to be the most efficient in inducing the chlorophyll mutations as compared to single treatments. Mutagenic effectiveness was found to be the maximum at high doses of γ rays and EMS whereas higher efficiency values were observed at lower concentration of EMS and middle doses of radiations. EMS was found to be a more effective and efficient mutagen than the rest of the mutagens. (Indian Sci. Abstr.)

Radiation Effects on Animals

Refer also to abstracts 2512 and 3026.

Man

Refer also to abstracts 2661, 3324, 4305, 4308, and 4309.

2744 (CEA-CONF-2068) RISKS INCURRED BY MAN AND THE ENVIRONMENT FROM RADIATION SOURCES. Jammet, H. ([Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires]). [nd]. 2p. (In French). (CONF-720453-2). Dep. NTIS (U. S. Sales Only).

From Meeting on radioactive waste disposal; Paris, France (12 Apr 1972).

The mode of irradiation must be taken into account when an evaluation is made of radiation risks posed by radioactive waste. Irradiation from radioactive waste is essentially of low level, of slow decay, and low relative biological effectiveness. Risk estimations must be based on hypotheses. Among these is the principal assumption that there is no threshold effect with respect to cancer induction and mutations and that there is a linear correlation between dose and both carcinogenesis and genetic damage. The mutagenic effects on man must be derived through uncertain extrapolations from animal studies. Actually, and for the foreseeable future, radiation risk from radioactive waste can be considered as minimal. (tr-auth)

2745 (CONF-720937-2) [RECENT DEVELOPMENTS IN RADIATION THERAPY OF PELVIC MALIGNANCIES]. Marcial, V. A. ([Puerto Rico Nuclear Center, San Juan]). 1972. 29p. Dep. NTIS.

From 7th national cancer conference; Los Angeles, CA. (27 Sep 1972).

With the exception of carcinoma of the vulva, radiation therapy is applicable in practically all malignant gynecological tumors as the treatment of choice or in combination with other modalities. In carcinoma of the cervix, radiotherapy is considered the treatment of choice. This is best given by means of external irradiation followed by intracavitary curietherapy. The five-year survival obtained is close to 90% in stage I, over 60% for stage II, 35% for stage III, and close to 20% for stage IV. Pre-operative radiotherapy should be administered to all adenocarcinomas of the endometrium. External irradiation followed by a limited intracavitary application has been found a useful technique particularly for stage II cases. Post-operative irradiation should be administered to all patients with malignant ovarian tumors. The addition of chemotherapy to radiation therapy appears to improve the survival of patients with advanced ovarian neoplasms. (auth)

2746 WHOLE-BODY, GONADAL, AND BONE-MARROW DOSES TO PERSONNEL OF X-RAY WARDS. Hajek, V.; Sedlacek, F.; Langmajer, J. (Military Hospital, Ruzomberok, Czech.). Cesk. Radiol.; 25: No. 4, 159-64(Jul 1971). (In Czech).

Over a year's period, measurements were carried out of the surface exposure of doctors and laboratory technicians of the x-ray ward; film dosimeters were used. From the data thus obtained the whole-body, gonadal, and bone-marrow doses were calculated. With doctors the results showed that the use of a single dosimeter resulted in underestimating the dose; to the gonads it was by a factor of 2.5, to the bone-marrow by 2.9. The doses, however, never exceeded the permissible values. No difference was found in the technicians. The long-term measurements made it possible to assess the effect of protection on the whole-body, bone-marrow, and gonadal doses. Exposure of the body was found to be more uniform when protective means had been used, and thus a single dosimeter placed on the chest provided reliable information on whole-body exposure. (NSA of Czech.)

2747 OSTEORADIONECROSIS OF JAWS AFTER IRRADIATION WITH ^{60}Co TELEGAMATHERAPY. Kopec, V.; Tomasek, J.; Beska, F. (Regional Hospital and Policlinic, Ostrava, Czech.). Cesk. Stomatol.; 71: No. 3, 159-62(May 1971). (In Czech).

Out of 68 patients irradiated with ^{60}Co γ for malignant disease of the oral cavity, jaws, and the neck, three patients (4.41%) developed osteoradionecrosis of the lower jaw and dental caries. Although the absorption of ^{60}Co γ radiation by the bones was smaller than in x-radiation, the threat of subsequent osteoradionecrosis of the jaw after irradiation with ^{60}Co remained. The teeth left in the irradiated region of the jaw constituted a permanent danger of a possible future cause of acute radionecrosis of the bone. Three cases are described, including etiology, pathogenesis and therapy, of osteoradionecrosis of the lower jaw. (NSA of Czech.)

2748 RADIATION-INDUCED CANCER: THE PRESENT POSITION. Saxby, M. (Univ. of Birmingham, Eng.). Radiography; 38: No. 451, 185-6(Jul 1972).

The symposium papers on radiation induced cancer are briefly reported under the following headings: Evaluation of risks; Childhood neoplasms; Thyroid cancer; Pharyngeal cancer; Breast cancer; Summary of the papers' implications; Occupational exposure in industry; and Discussion of Present I.C.R.P. dose limits. (UK)

2749 SEVENTEENTH ANNUAL MEETING OF THE HEALTH PHYSICS SOCIETY, 11 JUNE TO 15 JUNE 1972, LAS VEGAS, NEVADA. Health Phys.; 23: No. 3, 399-441(Sep 1972).

The 163 papers for which titles and abstracts are given cover all aspects of radiation hazards and radiation protection. (UK)

2750 SMALL HEAD SIZE AFTER IN-UTERO EXPOSURE TO ATOMIC RADIATION. Miller, R. W.; Blot, W. J. (National Cancer Inst., Bethesda, Md.). Lancet; 2: No. 7781, 784-7(14 Oct 1972).

For the first time, dose estimates were related to small head circumference induced by exposure in utero to the atomic bomb. There was a progressive increase with dose in the frequency of the abnormality among persons whose mothers were exposed before the 18th week of pregnancy. In Hiroshima the minimum dose-producing effect was 10 to 19 rad, but in Nagasaki no effect was observed under 150 rad. At maternal doses of 150 rad or more in both cities, small head circumference was often accompanied by mental retardation. It is pointed out that the observations at low doses in Hiroshima are not directly applicable to medical radiology because of the possible influence of neutrons (nil in Nagasaki) and perhaps to interactions with other environmental disturbances, more widespread in Hiroshima than in Nagasaki. (auth)

2751 ENVIRONMENTAL FACTORS IN THE EPIDEMIOLOGY OF LEUKEMIA IN HIROSHIMA AND NAGASAKI, 1945-67. Ishimaru, Toranosuke; Okada, Hiroshi; Tomiyasu, Takanori; Tsuchimoto, Taizo; Hoshino, Takashi (Atomic Bomb Casualty Commission, Hiroshima). Hiroshima Igaku; 25: No. 5, 623-35(May 1972). (In Japanese).

Investigative interviews were carried out during 1966 to 1969 on patients with leukemia who were found in Hiroshima and Nagasaki over the past 22 yrs (1945 to 1967) based on the registry of leukemia belonging to the ABCC and on controls. This survey was completed in 413 of 492 patients. The completion rate of the survey was 84%. A comparison concerning the following items was made in 413 pairs of combined leukemia patients with nonleukemia controls; address, householder's job, sanitary condition of residence, breeding of animals, and experience of whether or not to have been bitten by a dog. It was found that each item had no significant relationship to the occurrence of leukemia. In the 106 pairs of combined infantile leukemia patients and controls, A comparison was made concerning their mothers' age and their birth order. Consequently, no significant difference was statistically observed between both the groups. Relative risk, however, was liable to increase in proportion to the increase of mother's age. In the 303 pairs of combined adult leukemia patients older than 15 yrs of age with controls, a comparison was made of those in the group with professional experience dealing with benzene or its derivatives and medical x ray, and those in the group without it. The risk of the occurrence of leukemia seemed to be 2.5 times higher in the former than in the latter. The change of the relative risk of leukemia owing to summation of the two factors; the survivors of the atomic bomb and professional experience dealing with benzene or medical x ray, was also discussed. (Japan)

2752 BIOCHEMICAL DOSIMETRY: BIOCHEMICAL DIAGNOSTIC METHODS IN RADIATION INJURIES. Soerbo, Bo (Karolinska Institutet, Stockholm). Laekartidningen; 68: No. 46, 5301-7(1971). (In Swedish).

On the basis of the meeting of experts, organized by the IAEA in Paris, the biochemical indicators of radiation injury in man are examined, considering specifically the changes induced by radiation in blood and urine as a result of exposure to radiation. These biochemical changes may be used for diagnostic and prognostic purposes. Recently several biochemical indicators attracted special attention, especially creatine and deoxycytidine, but the state of the art is not sufficiently developed to use any of them routinely for the diagnosis and prognosis of radiation in-

juries. Combined use of several such methods could have a clinical value. (TTT)

2753 RELATIONSHIP OF REACTIONS TO COMPLICATIONS IN THE RADIATION THERAPY OF CANCER OF THE CERVIX. Kline, J. C.; Buchler, D. A.; Boone, M. L.; Peckham, B. M.; Carr, W. F. (Univ. of Wisconsin, Madison). Radiology; 105: No. 2, 413-16(Nov 1972).

A review was made of the reactions and complications associated with high-dose radiation therapy of invasive carcinoma of the cervix in 410 patients. In all patients, a combination of intracavity and external therapy was given. Either a bowel or urinary tract reaction or both developed in 133 of the 410 patients; one or more complications occurred in 94. As the severity of bowel reactions increased, the subsequent complication rate increased significantly, but 39% of those with bowel complications and 88% of those with urinary tract complications had no warning reaction. (auth)

2754 URANIUM MILL TAILINGS AND CANCER MORTALITY IN COLORADO. Mason, T. J.; Fraumeni, J. F. Jr.; McKay, F. W. Jr. (National Cancer Inst., Bethesda, Md.). J. Nat. Cancer Inst.; 49: No. 3, 661-4(Sep 1972).

A sandlike residue from uranium mills widely used as construction fill material since 1951 in Western Slope counties of Colorado was recently reported to be carcinogenic. We studied county-specific mortality statistics for cancer in Colorado through 1967 and found no trends attributable to this residential exposure to radiation. Continued monitoring of the population for radiation effects is needed. (auth)

2755 AGING IN HIROSHIMA AND NAGASAKI ATOMIC BOMB SURVIVORS: ACCUMULATION OF CARDIAC LIPOFUSCIN. Anderson, R. E.; Yamamoto, T.; Ishida, K.; Thorslund, T. W. (Atomic Bomb Casualty Commission, Hiroshima). Hiroshima Igaku; 25: No. 5, 636-9(May 1972). (In Japanese).

A survey on age dependent lipofuscin accumulation in the myocardium of the left ventricle was made in 54 cases bombed at a distance less than 1400 meters from the center of explosion in Hiroshima and Nagasaki, and simultaneously in the cases of the same number selected out of patients who didn't live in either of the two cities at the time of the atomic bomb under the consideration of the sex and the decimal grade of age at their death. As a result of this study, it was found that pigmentation has not been accelerated in the bombed subjects and the lipofuscin accumulation seemed more retarded in a large majority of the bombed subjects than non-bombed ones, although the difference was not significant statistically. Thus, the meaning of these findings was discussed. (Japan)

2756 LEUKEMIA AND DISEASES ALLIED TO IT WHICH WERE DISCOVERED ON PERIODIC EXAMINATION OF INDIVIDUALS EXPOSED TO FALLOUT RADIATION (ATOMIC BOMB). Toyoda, S.; Matsunaga, T.; Takeshita, K. (Nagasaki Atomic Bomb Hospital). Hiroshima Igaku; 24: No. 11, 1120-4(Nov 1971). (In Japanese).

Detailed examinations conducted on 4322 individuals exposed to fallout at Nagasaki in 1968, 3533 in 1969, and 3692 in 1970 revealed leukemia or diseases allied to it in four persons examined in 1968, three in 1969, and three in 1970; a total of 10. They consisted of three cases of chronic myelogenous leukemia, one case of chronic neutrophilic leukemia, three cases of lymphocytic leukemia, two cases of polycythemia vera, and one case with suspicion of myelofibrosis. The discovery and the course of the diagnosis were detailed for each case. (Japan)

2757 VARIATION OF LEUKOCYTE NUMBERS IN EMPLOYEES OF LABORATORIES AND RADIATION ROOMS. Katsumata, K.; Sato, Y.; Oya, T. (Nagoya Univ., Japan). Igaku No Ayumi; 81: No. 3, 136-8(Apr 1972). (In Japanese).

Forty employees engaged in radiography and work in radioisotope laboratories of the Hospital of Nagoya University were used as subjects for this study. Progressive changes in numbers of leukocytes in these subjects were studied for six years from 1965 to 1971 with a regular examination once a year. Accumulated x radiation doses in 14 subjects were recorded every year during the study. The relationship between the accumulated x radiation doses in each case and the decreasing rate of leukocyte numbers down to a level of 4,900 was investigated; some correlation was found. In those subjects whose numbers of leukocytes were less than 5,500, there were more cases in which numbers of leukocytes tended to go down below 4,900. During 6 years, there were none whose number of leukocytes was less than 4,000. (Japan)

2758 EYE EXPOSURE BY THORIUM CONTAINED LENSES. Notea, A.; Segal, Y. (Technion-Israel Inst. of Tech., Haifa). Health Phys.; 23: No. 6, 860-1(Dec 1972).

Certain lenses contain up to 20% by weight of thorium, added to achieve special optical properties. The use of these lenses in optical systems exposes the face, and especially the eyes to photons, α, and β radiations. An eye of 1.8 cm^2 placed 3 cm from such a lens would receive a dose of 0.15 mR/hr from γ rays, 0.20 mR/hr from low energy photons and β radiations and about 120 rem/hr from α radiation. Only a fraction of the α energy is lost in the tear film which acts as an absorber; thus the anterior surface of the cornea is exposed to a very high dose, about 60 rem/hr, while the inner layers receive a much lower dose. (UK)

2759 POPULATION MEAN MARROW DOSE AND LEUKAEMIA SIGNIFICANT DOSE FROM DIAGNOSTIC MEDICAL X-RAY EXAMINATIONS IN JAPAN, 1969. Hashizume, T.; Kato, Y.; Maruyama, T.; (and others) (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys.; 23: No. 6, 845-53(Dec 1972).

The 1969 population mean marrow dose and leukemia significant dose from diagnostic medical x ray examinations in Japan were estimated. The estimation was made based on a nationwide survey reported elsewhere. The bone marrow dose was measured using thermoluminescent dosimeters embedded in bone marrow sites in phantoms. The leukemia significant dose was calculated according to a weighting factor, the use of which takes into account the shape of the time-incidence curve of radiation induced leukemia, and the survival statistics for the various age groups in the population. The population mean marrow dose was 36.6, 26.8 and 126 mrad per person per year to radiography, photofluorography and fluoroscopy, respectively, with a total of 189 mrad. The leukemia significant dose was 32.7, 24.6 and 112 mrad, with a total of 169 mrad per person per year. (auth)

2760 RADIATION CONTROL IN HOSPITAL RADIOISOTOPE FACILITIES. Watanabe, Katushi (Kyushu Univ., Fukuoka). Rinsho Kagaku; 8: No. 1, 110-17(Jan 1972). (In Japanese).

Technical problems of radiation control in hospital radioisotope facilities, and of organization and administration are described. Problems include exposure of medical personnel during scintigraphy with ^{87m}Sr, ^{167}Yb, ^{18}F, and ^{67}Ga, and exposure of hospital employees and general public by patients given radioisotopes for treatment. The dose rate of radiation emitted by patients undergoing interstitial radioisotope therapy, and radioactivity contamination by excretions of patients who were given radioisotopes are indicated. Some discussions are made on the control of radiopharmaceuticals in relation to control mechanism and administrative organization of a hospital. In general, attention is drawn to the fact that problems arising from the form of examinations by nuclear medicine in a hospital are greater than the technical problems concerning radiation control. (auth)

2761 FUNDAMENTAL STUDIES ON THE MECHANISM OF INDUCTION OF LEUKEMIA. Yokoro, Kenjiro (Hiroshima Univ.). Nippon Ishikai Zasshi; 67: No. 10, 1303-14(May 1972). (In Japanese).

A ten-year literature survey was conducted of various factors concerned in the induction of leukemia. Epidemiological data are reported for radiologists, radiotechnicians, patients exposed to diagnostic or therapeutic radiation, and survivors of the atomic bomb explosions. Experimental studies with animals on leukemia induced by radioisotopes with emphasis on radioactive strontium are reviewed. The role of carcinogens, viruses, and hormones in leukemogenesis is discussed. Studies on radioinduced thymus lymphoma in mice are reviewed. Studies are reported on effects of thymectomy and Gross virus on radioinduced lymphoma in rats. (H.L.W.)

2762 ERSTE HILFE BEI STRAHLENUNFAELLEN. (First Aid for Radiation Accidents). Moehrle, G. (ed.). Stuttgart; A. W. Gentner Verlag (1972). 140p. (KFK-1691(Vol.47)).

The physical and biological bases of radiation effects on man are briefly reviewed. The measurement and diagnostic possibilities in the evaluation of a radiation burden and the recommended first aid procedures are given for all types of radiation accidents. These include physical determination of the personnel dose in acute partial or whole-body radiation, medical precautions in acute whole-body or partial radiation, contamination of the skin and decontamination methods, precautions in the event of contaminated injuries, determination of the body-burden in the event of incorporation of radionuclides, and methods for the removal of the incorporated radionuclides. (J.S.R.)

2763 GENETICALLY SIGNIFICANT DOSE FROM DIAGNOSTIC MEDICAL X-RAY EXAMINATIONS IN JAPAN, 1969. Hashizume, T.; Kato, Y.; Maruyama, T.; (and others) (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys.; 23: No. 6, 827-43(Dec 1972).

The 1960 genetically significant dose from diagnostic medical X-ray examinations in Japan has already been reported. The

present estimation was made based on a 1969 nation wide survey of randomly sampled hospitals and clinics. The number of examinations per year was 4 to 5 times that of 1960, but the genetically significant dose has not changed significantly. It was 15.2, 0.8 and 10.5 mrad per person per year for radiography, photofluorography, and photofluoroscopy, respectively, with a total of 26.5 mrad per person per year. (auth)

Vertebrates

Refer also to abstracts 2363, 2678, and 2693.

2764 (AEC-tr-7362) RADIOBIOLOGY. Translation of Radiobiologiya; 12: No. 2, 162-320(1972). 241p. Dep. NTIS.

Separate abstracts were prepared for the 28 papers in this cover-to-cover translation. (E.R.B.)

For abstracts of individual papers see: 2684, 2706, 2727–2731, 2765–2782, 2817, 2818, and 2840.

2765 (AEC-tr-7362, pp 24-30) EFFECTS OF GAMMA IRRADIATION ON THE SYNTHESIS OF PROTEINS INDUCIBLE BY ESTRADIOL IN THE UTERUS OF SEXUALLY IMMATURE RATS. Slozhenikina, L. V.; Fialkovskaya, L. A.; Kuzin, A. M. (Inst. of Biological Physics, Pushchino, USSR). Translated from Radiobiologiya; 12: No. 2, 176-9(1972).

Stimulation of the incorporation of ^{3}H-leucine into the acid-insoluble proteins of the uterus of control and irradiated sexually immature rats under in vitro conditions 6 and 24 hrs after the injection of estradiol was demonstrated. Irradiation of the animals at doses of 500 and 1000 R 24 hrs before the injection of estradiol had no inhibiting effect on the synthesis of inducible proteins. A conclusion is drawn on the relative stability of the macromolecular system that carries out protein synthesis in the presence of a hormonal inducer to the action of ionizing radiation. (tr-auth)

2766 (AEC-tr-7362, pp 31-9) INVESTIGATION OF RIBONUCLEASE ACTIVITY IN ORGANS OF IRRADIATED ANIMALS. Paskevich, I. F.; Shantyr, V. I.; Savenko, L. N.; Ishkhanova, M. A.; Likhoded, V. S. Translated from Radiobiologiya; 12: No. 2, 180-5(1972).

The activity of ribonuclease of the liver and spleen of white rats x-irradiated at a dose of 800 R was investigated 2, 24, 48, and 72 hrs after irradiation. It was established that the activity of the nuclear ribonuclease is significantly reduced in comparison with the norm, while the activity of the cytoplasmic ribonuclease (optimum pH 5.2 and 8.0) is increased. The nuclear and cytoplasmic ribonucleases differ in products of hydrolysis of RNA. (tr-auth)

2767 (AEC-tr-7362, pp 40-7) QUANTITATIVE EVALUATION OF THE RADIOSENSITIVITY OF THE GENETIC STRUCTURES OF MAMMALIAN SOMATIC CELLS. Strzhizhovskii, A. D. Translated from Radiobiologiya; 12: No. 2, 186-91(1972).

The results of a quantitative analysis of the postradiation changes in the mitotic activity and frequency of aberrant mitoses in cells of certain tissues of rodents in vivo are presented. A treatment of the experimental material available in the literature permitted a determination of the duration of the first postradiation cycle, the frequency of aberrant mitoses in it, as well as the spectrum of the distribution of the frequency of aberrant mitoses according to the cycle in cells of the bone marrow, liver, corneal epithelium, and intestines under the influence of x ray and γ radiation, fission neutrons, and high-energy protons. (tr-auth)

2768 (AEC-tr-7362, pp 48-57) FACTORS INFLUENCING CLASMATOSIS IN VIVO. IV. RESPONSE OF THE LYMPHOID ORGANS OF RATS AND MICE TO LOCAL IRRADIATION OF THE BONE MARROW. Kabakov, E. N. (Scienfific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 12: No. 2, 192-8(1972).

In experiments on local x irradiation of rats and mice, the dynamics of the relative content of free cytoplasmic fragments formed in the lymphoid organs as a result of clasmatosis of lymphocytes was determined and compared with the indices of hematogenesis in the bone marrow and spleen and with cytometric data. Just as under other influences affecting the direction of cell differentiation in the reticuloendothelial system, the response to local irradiation is systemic in nature, but the shape of the curves describing it differs from that observed in the case of whole-body irradiation, immunization, and intraperitoneal injection of Freund's adjuvant. The most active clasmatosis coincides in time with the shift of the size distribution of lymphocytes in the direction of large cells. The results obtained confirmed the hypothesis of a relationship of clasmatosis to differentiation of the lymphocytes. (tr-auth)

2769 (AEC-tr-7362, pp 58-66) DETERMINATION OF THE COLONY-FORMING ABILITY OF STEM CELLS AND THEIR INACTIVATION BY ALLOGENEIC LYMPHOCYTES BY THE METHOD OF HISTOLOGICAL SECTIONS OF THE SPLEENS OF IRRADIATED RECIPIENTS. Man'ko, V. M.; Shvets, V. N. (Institute of Biophysics, Moscow). Translated from Radiobiologiya; 12: No. 2, 199-204(1972).

The colony-forming ability of stem cells and their inactivation by allogeneic lymphocytes were determined considering a count of macroscopically visible colonies on serial histological sections of the spleens of irradiated recipients. Both methods used reveal essentially the same patterns. In systems of exogenous or endogenous colony formation, the lymphocytes transplanted into lethally or sublethally irradiated mice almost entirely inactivate nonsyngeneic colony-forming cells (CFU). The inactivation of nonsyngeneic CFU is expressed by blockage or sharp inhibition of the reproduction of stem elements. As a result, most of the CFU do not give colony formation, while the colonies that grow are characterized by small size. The stem cells differentiated according to all types of hematogenesis, not only in the spleen, but also in the bone marrow cavity of the femur of irradiated mice, undergo inactivation. (tr-auth)

2770 (AEC-tr-7362, pp 67-73) INFLUENCE OF ADRENALECTOMY ON COLONY FORMATION IN THE SPLEENS OF IRRADIATED MICE. Kabakov, E. N.; Konoplyannikov, A. G. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 12: No. 2, 205-9(1972).

Preradiation adrenalectomy of mice of the CBA line increases the yield of endocolonies in the spleen in comparison with those in intact and sham-operated animals by 2.5- to 3-fold. When adrenalectomized mice are used as lethally irradiated recipients of bone marrow from intact mice, the yield of CFU per 10^5 transplanted cells is increased by about 60% in comparison with the data of experiments in which intact or sham-operated recipients were used. It is suggested that the volume of the pool of stem cells and their colony-forming potentials are under the regulating influence of the pituitary-adrenal system. (tr-auth)

2771 (AEC-tr-7362, pp 74-83) INTENSIFICATION OF THE MIGRATION OF HEMATOGENIC STEM CELLS IN THE ORGANISM OF NONUNIFORMLY IRRADIATED MICE AFTER THE INJECTION OF THYMIDINE AND DNA. Khaitov, R. M.; Evseeva, N. K.; Seslavina, L. S.; Shvets, V. N.; Uspenskaya, M. S. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 12: No. 2, 210-15(1972).

The influence of injection of heterologous DNA and thymidine on the intensity of the migration of colony-forming stem cells from shielded bone marrow of mice after irradiation with x rays in lethal doses was studied. It was shown that DNA and thymidine, without influencing the differentiation of the stem cells, significantly increased the number of endogenous colonies in the spleens of nonuniformly irradiated mice. The introduction of these preparations into totally irradiated mice does not cause any increase in the number of endogenous colonies. The data obtained are evidence that the increase in the number of colonies in the spleens of "shielded" mice after the injection of DNA or thymidine occurs as a result of an intensification of the migration of stem cells from the protected bone marrow. (tr-auth)

2772 (AEC-tr-7362, pp 84-91) INFLUENCE OF TOTAL EXTERNAL IRRADIATION WITH BETA PARTICLES ON CERTAIN INDICES OF THE NATURAL IMMUNITY IN RATS. Shal'nova, G. A.; Smirnov, A. V. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 12: No. 2, 216-20(1972).

Total external β irradiation at doses of 800 and 4500 rad causes an inhibition of the nonspecific anti-infectious resistance in rats (increase in microbes of the autoflora of the skin and mouth, disruption of the qualitative composition of the autoflora of the mouth, and inhibition of the bactericidal activity of the mucosa). Serious and profound changes are noted at a dose of 4500 rad, while at a dose of 800 rad they do not always differ significantly from the control indices. The degree of disruption of the indices of natural immunity is more pronounced in males than in females. (tr-auth)

2773 (AEC-tr-7362, pp 92-104) INVESTIGATION OF THE RELATIONSHIP OF THE HYPOXIC AND PROTECTIVE INFLUENCE OF CERTAIN RADIOPROTECTORS. Sverdlov, A. G.; Martynchik, Yu. F.; Yarkovets, A. G. (Ioffe Inst. of Physics and Tech., Leningrad). Translated from Radiobiologiya; 12: No. 2, 221-8(1972).

The radioprotective activity of various radiomodifying agents — sulfur-containing compounds and indolylalkylamines — was compared with their influence on oxygen pressure (pO_2) in the spleen and muscles of mice. It was shown that no strict correspondence is observed between the influence of the tested substances on pO_2 in the tissues and their protective activity. On the basis of an analysis of the data obtained, it was concluded that the mechanism of radiation protection by indolylalkylamines is not exhausted by

their hypoxic action, while the protective activity of sulfur-containing protectors depends even less on their influence on pO_2 in the tissues, although there is such an influence. (tr-auth)

2774 (AEC-tr-7362, pp 105-22) ANALYSIS OF THE MECHANISM OF ACUTE RADIATION SICKNESS. Suslikov, V. I. (Inst. of Experimental and Clinical Oncology, Moscow). Translated from Radiobiologiya; 12: No. 2, 229-39(1972).

A method is proposed for the quantitative evaluation of the specific role of the distant interchangeable components (the integrating mechanism) of radiation lesions in the lethal effect of ionizing radiation. An analysis of the literature data obtained for various types of ionizing radiations (γ, β, and x rays) on different species of animals (mice, rats, and dogs) in a broad range of lethality (from 10 to 90%) and in a broad range of exposure doses of irradiation (from 250 to 20,800 R) shows that the specific contribution of the integrating component is no less than 90%. (tr-auth)

2775 (AEC-tr-7362, pp 123-32) PRINCIPLES OF THE BIOLOGICAL EFFECTS OF RADIATIONS UNDER CONDITIONS OF A NONUNIFORM DISTRIBUTION OF THE ABSORBED DOSES. Darenskaya, N. G.; Avetisov, G. M.; Nelyubov, A. A.; Sokolova, I. K. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 12: No. 2, 240-6(1972).

Experimental data are presented on the degree of radiation lesion of rats, rabbits, and dogs under conditions of total nonuniform influences (unilateral caudo-cranial and cranio-caudal irradiation with γ and x rays). It was shown that for each species of animals in the range of lethal doses, the degree of radiation lesion decreases with increasing drop of the tissue dose along the longitudinal axis of the body. Species peculiarities of lesion under conditions of total nonuniform influences are discussed. A mathematical model describing the functional dependence of the degree of lesion on the coefficient of the tissue dose gradient is presented for the modes of irradiation of rats considered. (tr-auth)

2776 (AEC-tr-7362, pp 181-9) RELATIVE BIOLOGICAL EFFECTIVENESS OF FISSION NEUTRONS. Sverdlov, A. G.; Mozzhukhin, A. S.; Pavlova, L. M.; Lavrova, G. A.; Nikanorova, N. G.; Postnikov, L. N. (Ioffe Inst. of Physics and Tech., Leningrad). Translated from Radiobiologiya; 12: No. 2, 279-84(1972).

The RBE coefficient of fission neutrons with average energy 1.85 MeV was determined for several biological reactions. The RBE values depend on the contribution of neutrons to the total dose of irradiation; regardless of the fraction of the γ component, the RBE values decrease with increasing dose of radiation. The RBE of neutrons, estimated according to $LD_{100/30}$, is 2.85 for mice. Peculiarities in the distribution of the absorbed dose in small and large laboratory animals are described; with increasing mass of the animal in the central portion of the phantom, the dose of the γ component in the total dose of radiation increases. On the basis of phantom investigations and the values obtained for the RBE, a tentative calculation was made of the value of this coefficient for larger animals. In dogs it is tentatively 1.1 to 1.2. (tr-auth)

2777 (AEC-tr-7362, pp 190-5) INVESTIGATION OF THE ACCEPTOR ACTIVITY OF TRANSFER RNA AND AMINOACYL-tRNA SYNTHETASES OF THE LIVER AND SPLEEN OF IRRADIATED RATS. Chagovets, E. M. Translated from Radiobiologiya; 12: No. 2, 285-95(1972).

In cross experiments using tRNA and aminoacyl-tRNA synthetases from the tissues of normal animals and animals irradiated at a dose of 800 R in the system, a disturbance of the formation of aminoacyl-tRNA after irradiation was detected. This is due in some cases to a disruption of the acceptor function of individual tRNAs, and in others to a change in the activity of the enzymes. In the spleen, the acceptor activity of the phenylalanine, arginine, lysine, valine, and glutamine tRNAs is suppressed, while that of the leucine forms is unchanged. In the liver, the activity of the tRNAs specific for phenylalanine and glutamic acid is unchanged, while the remaining investigated transfer RNAs either increase their ability to accept amino acid (arginine and lysine tRNAs) or show no change in it (valine and leucine tRNAs). (tr-auth)

2778 (AEC-tr-7362, pp 196-200) INFLUENCE OF MELANIN PIGMENTS FORMED BY MICROORGANISMS ON THE RESISTANCE OF MICE TO X RADIATION. Malama, A. A.; Ternov, V. I.; Khramenko, G. B.; Danil'chik, N. I. (Belorussian State Univ., Minsk). Translated from Radiobiologiya; 12: No. 2, 289-91(1972).

New data are presented on the study of the radioprotector properties of fractions 2 and 3 of melanin pigments of microbial origin It was shown that these pigments have low toxicity, and in the case of parenteral administration at a dose of 10.0 to 50.0 mg/kg of weight are capable of increasing the radioresistance of mice to some degree. The possible mechanism of the radioprotective activity of melanin pigments is discussed. (tr-auth)

2779 (AEC-tr-7362, pp 201-8) RADIOSENSITIVITY OF THE MEGAKARYOCYTES. Rudakov, I. A.; Tsygankova, V. A.; Rudakova, S. F. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 12: No. 2, 292-7(1972).

In a quantitative and morphological study of the megakaryocytes of the bone marrow of CBA mice after irradiation at doses of 400, 600, and 800 R, it was established that the main cause of the observed changes is the sharp inhibition of the transition of precursor cells to megakaryocytes. An important role is also played by radiation damage to the early generations of megakaryocytoblasts and their precursors, leading to an increase in the content of degenerative forms, a decrease in the size of the megakaryocytes, and a sharp reduction of thrombocyte production. The direct injurious action of radiation on mature megakaryocytes does not play any significant role in comparison with the first two mechanisms. (tr-auth)

2780 (AEC-tr-7362, pp 209-15) ROLE OF FACTOR XIII IN THE MAINTENANCE OF THE INTEGRITY OF THE WALLS OF THE VESSELS DURING ACUTE RADIATION SICKNESS. Ponomarev, Yu. T.; Zhukova, N. A. (Scientific Research Inst. of Medical Radiology, Obninsk, USSR). Translated from Radiobiologiya; 12: No. 2, 297-301(1972).

Various plasma components of the blood of healthy donors, produced by gel filtration through Sephadex G-200, were administered to rats of the Wistar line and guinea pigs at the height of acute radiation sickness. It was shown that the plasma fractions with the activity of factor XIII normalize fibrin formation and the properties of a fibrin clot, increase the adhesiveness of the blood platelets and the stability of their aggregates, lower the indices of bleeding, and increase the resistance of the vessels. The plasma components that do not possess factor XIII activity have no influence on the hemorrhagic manifestations of radiation sickness. (tr-auth)

2781 (AEC-tr-7362, pp 216-19) CHANGES IN THE CRYSTALLINE LENS OF RATS UNDER THE ACTION OF TOTAL EXTERNAL BETA IRRADIATION. Milovidova, I. A.; Moskalev, Yu. I. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 12: No. 2, 301-3(1972).

Total external β irradiation in the dose range 800 to 4500 rad causes the development of radiation cataracts in rats. The latent period of development of cataracts is inversely dependent on the dose of irradiation, while the frequency of appearance of cataracts and the degree of opacification of the crystalline lens are directly dependent on the dose of irradiation. (tr-auth)

2782 (AEC-tr-7362, pp 220-4) MATHEMATICAL ANALYSIS OF THE CHANGE IN THE NUMBER OF LEUKOCYTES IN DOGS IN COMBINED LOW-POWERED GAMMA IRRADIATION. Popova, N. A.; Appak, N. M.; Burkovskaya, T. E. Translated from Radiobiologiya; 12: No. 2, 303-6(1972).

For a period of three years, mongrel male dogs were subjected to total chronic γ irradiation at a rate of 0.17 rad/day, and against this background single irradiations at a rate of 2.1 rad/hr, dose of each irradiation 42 rad, were administered at four-month intervals. The absolute number of leukocytes in 1 mm^3 of peripheral blood was studied by means of dispersion analysis and approximation with polynomials 0, 3, 7, 14, 21, 28, and 60 days after each irradiation. With the accumulation of a total summary dose of the order of 400 rad, the nature of the response of the leukocytes to single repeated irradiations is changed. (tr-auth)

2783 (CEA-N-1562) CHANGES OF ARTERIAL BLOOD PRESSURE, HEART RATE, AND INTERNAL BODY TEMPERATURE IN THE UNANAESTHETIZED RABBIT FOLLOWING WHOLE-BODY GAMMA IRRADIATION AT A MEAN ABSORBED DOSE OF 450 RADS. Dufour, R.; Court, L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Oct 1972. 25p. (In French). Dep. NTIS (U. S. Sales Only).

The general effects of a mean absorbed whole-body dose of 450 rads of γ irradiation were studied with unanaesthetized rabbits in association with spontaneous electroencephalographic activities. Modifications occurring in the arterial blood pressure, heart rate, and internal body temperature were measured during the 5 days following exposure. Such changes were observed to take place very rapidly after the exposure. The arterial blood pressure increased slightly during the first 30 minutes and then rapidly decreased reaching a minimum between 1 hour 45 minutes and 2 hours after the exposure; the hypotension lasted until the 5th day. The heart rate increased from the 15th minute after exposure. The tachycardia reached a maximum within the 1st hour and disappeared 48 hours later. The internal body temperature increased after the 15th minute. The hypothermia reached a maximum after 1 hour. The principal thermolysis factors in rabbits are lung ventilation and cutaneous circulation in the ear. These factors were deter-

mined from measurements of the CO_2 pressure in the arterial blood and the ear skin temperatures. (France)

2784 (JPRS-57187) ROLE OF MIXED DISULFIDE BONDS IN THE RADIOPROTECTIVE EFFECT OF β-MERCAPTOETHYLAMINE (MEA). Filippovich, I. V.; Zhulanova, Z. I.; Kolina, V. B.; Mikhaylova, L. P.; Sheremet'evskaya, T. N.; Romantsev, E. F. (Translated from Dokl. Akad. Nauk SSSR; 204: No. 4 1006-9(1972). 6p. NTIS.

Results are reported of an investigation of mixed disulfide bonds of mercaptoethylamine (MEA) with proteins of the thymus hyaloplasm and of some subcellular structures of the spleen and liver in rats at various time intervals after administration of the radioprotector to the animals. This is one of many investigations performed to determine the radioresistance of the animal after the radioprotector administration. (auth)

2785 (KURRI-TR-87) ALTERATION FACTORS OF RADIATION INJURY. Ishida, Masahiro; Oijima, Takaharu (eds.) (Kyoto Univ. (Japan). Research Reactor Inst.). 1971. 47p. (In Japanese). Dep. NTIS (U. S. Sales Only).

English language abstracts are included for four of the seven individual reports that discuss radiation injury to biological systems. Three papers were abstracted and appeared in NSA previously. (H.L.W.)

For abstracts of individual papers see: 2709, 2733, 2734, and 2819.

2786 CHANGE IN BLOOD PROTEIN COMPOSITION OF ACCLIMATIZED ANIMALS AFTER X IRRADIATION. Akopyan, N. S. Uch. Zap. Erevan. Univ., Estestv. Nauk; No. 2, 50-5(1970). (In Russian).

The albumin : globulin ratio of blood of rabbits acclimatized at an altitude of 3200 m increased in comparison with control animals. In the early postnatal period of development the blood albumin content was higher than the globulin fraction content. The compensatory hyperglobulinemia reaction to irradiation-induced (700 R) hypoalbuminemia was slightly manifested in newborn rabbits. (JPRS)

2787 INFLUENCE OF ACUTE AND FRACTIONAL X IRRADIATION ON INDUCTION OF INTERFERON IN VIVO. Talas, M.; Szolgay, E.; Varteresz, V.; Koczkas, G. (Hungarian Academy of Sciences, Budapest). Arch. Gesam. Virusforsch.; 38: No. 2-3, 143-8(1972).

Acute x irradiation with 350 R increased the synthesis of interferons induced by poly I : C and endotoxin in individual sera of BALB/c mice. Fractional irradiation with 4.7 or 9.4 R daily up to total dose levels of 728, 977, and 1828 R in three different experiments had no influence on serum interferon levels induced by Semliki Forest Virus (SFV), poly I : C, or endotoxin. The Newcastle Disease Virus (NDV) induced interferon synthesis decreased in comparison to the non-irradiated control at a total dose of 400 R and attained the control level on further elevation of the total dose. The anti-NDV antibody production fell to one quarter of the control value after exposure to a total dose of 1828 R. (auth)

2788 CHANGES IN CARDIOVASCULAR SYSTEM DURING EXPERIMENTAL RADIATION DISEASE. Kuna, P. (Military Medical Research and Postgraduate Inst., Hradec Kralove, Czech.). Cas. Lek. Cesk.; 110: No. 21, 486-91(21 May 1971). (In Czech).

The data are reviewed from published literature in the years 1965 to 1969 on radiation-induced changes in the cardiovascular system. Briefly presented are the results of the study of the effect of cystamine on the content of nucleic acids, free amino acids and non-collagenic protein in the myocardium of rats exposed to 700 R of gamma-radiation. No changes were found in free amino acids. An increased concentration was observed of DNA four days after exposure; this increase was significant 10 days after exposure. A decrease was found in RNA and non-collagenic protein, which could be prevented by the prophylactic administration of cystamine. (NSA of Czech.)

2789 SEX RATIOS AND RETARDATION OF GONADAL DEVELOPMENT IN CHRONICALLY GAMMA-IRRADIATED CHINOOK SALMON SMOLTS. Bonham, K.; Donaldson, L. R. (Univ. of Washington, Seattle). Trans. Amer. Fish. Soc.; 101: No. 3, 428-34(Jul 1972).

The gonads of 4,405 premigratory smolts from eight year classes of chinook salmon, Oncorhynchus tshawytscha (Walbaum) were inspected to determine sex. Nearly half of the smolts of seven of the year classes were irradiated for their first 80 days of life by exposure to the gamma rays of cobalt-60 at rates that increased almost exponentially from 0.5 R/day the first year to a maximum of 50 R/day the last year. Sex ratios were unaffected by 5 R/day or less, but at 10 or more R/day gonadal development was retarded. (auth)

2790 LEVELS OF SERUM LYSOZYME AND TRYPSIN INHIBITORS AND THE NUMBER OF LEUKOCYTES IN RABBITS AFTER X-IRRADIATION. Stefanovic, J.; Absolonova, O. (Comenius Univ., Bratislava). Bratislav. Lek. Listy; 54: No. 5, 618-25(Nov 1970). (In Slovak).

The levels of lysozyme and trypsin inhibitors of serum and changes in the number of leukocytes were observed in rabbits after whole-body x-irradiation with doses of 150, 500, and 1000 R. In rabbits irradiated with a dose of 150 R an increased level of serum lysozyme and of trypsin inhibitors of serum was observed in the first days after exposure. The changes were not significant. In the number of leukocytes, no marked changes were found resulting from this dose. In rabbits irradiated with a dose of 500 R the lysozyme level oscillated. A decrease was mostly found lasting for up to the 21st day of observation and rapidly followed by a significant increase. The activity of trypsin inhibitors of serum increased rapidly after irradiation, with a maximum on the 4th day. It maintained the same level for up to the 7th day when an oscillation and a decrease occurred. The value returned to the initial level on the 29th day. The number of leukocytes decreased significantly, with a minimum on the 4th day. This was maintained for up to the 14th day. A progressive increase was then observed. The value, however, only reached the initial level on the 29th day. A dose of 1000 R resulted in a decrease to zero values in all parameters. The animals died 5 days after irradiation. (NSA of Czech.)

2791 SURVIVAL OF ^{51}Cr-LABELED ERYTHROCYTES FOLLOWING VARIOUS DOSES OF WHOLE-BODY X-IRRADIATION. Prouza, Z.; Pospisil, J.; Dienstbier, Z. (Charles Univ., Prague). Cas. Lek. Cesk.; 110: No. 22, 502-8(28 May 1971). (In Czech).

Variations were studied of the half-life of the survival of erythrocytes in rats, guinea-pigs and dogs with the magnitude of the absorbed dose resulting from the whole-body exposure of the organism. The survival half-life of erythrocytes was found to be shortened, as a result of whole-body exposure, with increasing the absorbed dose. The mechanism of changes resulting in shortening the survival half-life of erythrocytes is described. (NSA of Czech.)

2792 BLASTOMOGENIC EFFECT OF IONIZING RADIATION USED DURING THE ANTENATAL DEVELOPMENT. Piontkovskii, I. A.; Kalashnikova, M. S. (Inst. of Higher Nervous Activity and Neurophysiology, Moscow). Patol. Fiziol. Eksp. Ter.; 16: No. 2, 13-17(Mar 1972). (In Russian).

Radiation-induced tumors in 526 rats were studied during an 18-day period of antenatal development following single doses of 10, 25, 50, and 200 R. The effect of exposure to x radiation was to increase the number of tumors by a factor of three. Peculiarities in localization and in tissue characteristics of the induced tumors were detected in the irradiated animals. (tr-auth)

2793 PIGMENT CLUMPING IN GROWING HAIR FOLLICLES OF MICE. A SENSITIVE RADIOBIOLOGICAL MODEL. Potten, C. S. (Christie Hospital and Holt Radium Inst., Manchester, Eng.); Forbes, P. D. Int. J. Radiat. Biol.; 22: No. 4, 337-49(Oct 1972).

A new method is described for analyzing damage in mouse hair follicles, involving the production of densely pigmented cells in an abnormal location: the mitotically active matrix region of the growing hair follicle. This hyperpigmentation is a sensitive indicator, produced by relatively low doses of radiation or chemicals. As used here, the change is quantal, follicles being recognized as normal-appearing or affected on the third day after treatment. The fraction of normal follicles decreased exponentially with increasing dose of three treatment modalities: x-rays to the skin surface, ultra-violet radiation to the skin undersurface, or actinomycin-D injected subcutaneously. The dose-response curves extrapolated to a number between 1.5 and 2.1 and they had D_0 values of 55 rads of x-rays, 105 mJ/cm^2 of U.V.R., or 42.5 μg of actinomycin-D/kg body-weight. The D_{50} doses were 70 rads, 105 mJ/cm^2, and 43 μg/kg, respectively. (auth)

2794 EXPERIMENTAL BRAIN LESIONS INDUCED BY ^{90}Y. Fusek, I.; Fuchsova, M. (Central Military Hospital, Prague). Voj. Zdravot. Listy; 15: No. 5, 187-90(Oct 1971). (In Czech).

The effect was studied in dogs of beta radiation on the normal brain tissue. Ten brain lesions were induced in 10 dogs by the implantation of ^{90}Y granules of various activity. The macroscopic and microscopic assessment showed that the resulting necrotic deposits had the constant form of an ellipsoid of revolution. The lesions consisted of completely destroyed brain tissue bordered by a narrow edge of gliosis and minor hemorrhages. Older lesions showed central pseudocysts. The collateral oedema of the brain was found to disappear within three weeks after the implantation of the radioisotope. The extent of necrosis was proportional to the activity of the ^{90}Y granule. The correlation coefficient was 0.9754.

To increase the necrosis by 1 sq.cm the activity of the radioisotope had to be increased by 8.6 mC. (NSA of Czech.)

2795 EFFECT OF BETA-RADIATION (^{90}Sr) ON NERVOUS PLEXUS OF CORNEA. I. STUDY BY VITAL STAINING WITH METHYLENE BLUE. Simkova, M. (Charles Univ., Prague). Cesk. Oftalmol.; 27: No. 4, 212-17(Jul 1971). (In Czech).

In rabbits divided into four groups, the central part of the cornea, 6 mm in diameter, was exposed to beta radiation from a ^{90}Sr source, at a total dose of 3000, 5000, 7500, and 10,000 rads, respectively. Changes in the central nervous plexus were studied using vital staining with methylene blue. After a certain period of latency that depended on the dose rate, changes were observed characterized by primary regressive signs in the irradiated areas. The peripheral nervous plexus showed a normal appearance. Higher doses of irradiation were found to result in earlier and more intensive secondary regeneration and hyper-regeneration. The relation of the intensity of degenerative and regenerative changes in the cornea to the total dose of irradiation was thus confirmed. (NSA of Czech.)

2796 EFFECT OF BETA-RADIATION (^{90}Sr) ON NERVOUS PLEXUS OF CORNEA. II. STUDY BY SILVER IMPREGNATION. Vrabec, J.; Simkova, M. (Charles Univ., Prague). Cesk. Oftalmol.; 27: No. 4, 218-22(Jul 1971). (In Czech).

In rabbits divided into four groups, the central part of the cornea was exposed to beta-radiation from a ^{90}Sr source at a total dose of 3000, 5000, 7500, and 10,000 rads, respectively. The corneal innervation was studied by silver impregnation 3, 5, 6, 9, 14, 21, and 28 days after exposure. Degenerative signs were observed as primary changes in the corneal nervous plexus since the first examination. In non-irradiated peripheral nervous plexus regenerative and hyper-regenerative changes were observed which were induced by 3000 rads in 21 days, by 5000 rads in 14 days, by 7500 rads in 9 days, and by 10,000 rads in 5 days. Regenerative fibres were found to penetrate from the undamaged part of the cornea to the irradiated area. (NSA of Czech.)

2797 ASSAY TO AFFECT THE POSTIRRADIATION DISTURBANCE OF BLOOD COAGULATION. Klir, P.; Pospisil, J.; Skala, E.; Dienstbier, Z. (Charles Univ., Prague). Vnitr. Lek.; 17: No. 10, 937-42(Oct 1971). (In Czech).

Ellagic acid was found to decrease significantly the blood loss in rats after whole-body irradiation if administered at a dose of 10 ml/kg in 2×10^{-4}M solution. Under similar conditions, haemarctin, reptilase and dicynone were without effect. In experiments in vitro, ellagic acid normalized the pathological TEG record of the hemophilic blood, blocked the effect of heparin and prolonged the coagulation time of the test of prothrombin consumption in the blood of healthy subjects. (NSA of Czech.)

2798 POST-IRRADIATION RESTORATION OF SOMATIC CELL CHROMOSOMES IN MAMMALS. THE INFLUENCE OF THYROXINE ON THE FREQUENCY OF CHROMOSOME ABERRATIONS IN LIVER CELLS OF RATS. Yudin, G. I.; Antipenko, E. N. (Inst. of Radiology and Oncology, Kiev). Int. J. Radiat. Biol.; 22: No. 5, 501-6(Nov 1972).

The influence of thyroxine and its deficiency (thyroidectomy) on the frequency of chromosome aberrations in regenerating liver cells of x-irradiated (doses of 150, 200, and 250 R) and unirradiated rats was investigated. Thyroxine and thyroidectomy both produced chromosome damage, but also had a significant effect on the amount of radiation-induced chromosome damage. Thyroxine given daily for a period of 2 months after irradiation reduced the amount of chromosome damage to the control (unirradiated) level. This is achieved either as a direct effect on repair of damage or indirectly by increasing cell-proliferation rate. Thyroidectomy increased the frequency of radiation-induced chromosome damage. (auth)

2799 PROTECTION AGAINST LOCAL IRRADIATION INJURY TO THE SKIN BY LOCALLY AND SYSTEMICALLY APPLIED DRUGS. Lowy, R. O.; Baker, D. G. (Mount Zion Hospital, San Francisco). Radiology; 105: No. 2, 425-8(Nov 1972).

The radioprotective effects of systemically and topically administered cysteamine and WR-2721 were studied in irradiated mouse skin. Topically applied cysteamine showed significant protection only with moderate doses of irradiation. Topically applied WR-2721 had no protective effect at any dose. Systemically administered cysteamine yielded a dose reduction factor (DRF) of 1.7 for acute skin reactions and WR-2721 yielded a DRF of 2.0. Both agents showed a DRF of 1.5 for late tissue changes when administered systemically. The DRF for late tissue changes following local irradiation may be a more meaningful parameter of protective action than the DRF for acute whole-body lethality. (auth)

2800 RADIATION-INDUCED HAIR-FOLLICLE DAMAGE AND TUMOR FORMATION IN MOUSE AND RAT SKIN. Albert, R. E.; Burns, F. J.; Bennett, P. (New York Univ., N. Y.). Contract AT(11-1)-3380. J. Nat. Cancer Inst.; 49: No. 4, 1131-7(Oct 1972).

The dorsal skin of 158 Swiss Millerton mice was irradiated with electrons in single exposures at 6 dose levels from 500 to 4,000 rads. The mice were observed for skin-tumor formation every 4 weeks for 88 weeks. At death, each tumor was examined histologically, and whole-skin mounts were used to determine the survival of intact hair follicles and the incidence of atrophic follicles. These data were compared with the dose-response characteristics for tumor induction and hair-follicle survival in the rat from previous experiments. The incidence of epithelial skin tumors was markedly lower in mice than in rats. This difference was due to the failure of mice to develop adnexal tumors, which are the predominant type of skin tumor in the rat. The radiation sensitivity of mouse skin for hair-follicle destruction was at least twice that of the rat. The relatively low level of atrophic follicle formation in the mouse skin as a consequence of radiation damage may be related to the failure to develop adnexal skin tumors. (auth)

2801 COCARCINOGENIC ACTION OF MECHANICAL DAMAGE AND X-RAY IRRADIATION ON INTRAMANDIBULAR TISSUE OF MICE. Eulderink, F.; van Rijssel, Th. G. (Instituut voor Radiopathologie en Stralenbescherming, Leiden). J. Nat. Cancer Inst.; 49: No. 3, 821-7(Sep 1972).

The effect of combined x-ray irradiation and continuous mechanical irritation was studied. Chronic mechanical irritation of enamel-forming epithelium by implantation of nylon threads or steel wires in alveolar sockets of (♀ WLLf × ♂ O_{20})F_1 mice, which induces intramandibular carcinoma, was combined with x-ray irradiation of the head in a single dose of 500 or 1000 rads. These doses did not induce tumors when applied without other treatment. Implantation and irradiation together caused a marked increase of the number of induced tumors as compared with implantation alone. Both carcinomas and benign mesenchymal tumors (osteofibromas) developed. At a dose level of 500 rads, this increase was significant for carcinomas and for all types of tumor; at a dose of 1000 rads this was true for all tumors but not for carcinomas alone. Combined with thread implantation, irradiation gave more tumors in a dose of 500 rads than in one of 1000 rads; for carcinomas this was statistically significant. At higher dose levels the cell-damaging action of the x rays probably interferes with the carcinogenic influence. (auth)

2802 NUCLEOSIDE DEAMINASE ACTIVITY DURING THE RECOVERY OF X-IRRADIATED, BONE MARROW-PROTECTED MICE. Basch, R. S.; Malathi, V. G.; Silber, R. (New York Univ., N. Y.). J. Cell. Physiol.; 80: No. 2, 261-5(Oct 1972).

Increased activity of the enzyme nucleoside deaminase is found in the spleens of mice protected from lethal whole-body irradiation by transfusion of isogeneic bone marrow cells. As few as 10,000 nucleated bone marrow cells produce a significant elevation in enzyme level. This increase precedes any detectable increase in hemoglobin synthesis and is temporarily associated with an increase in protein synthesis during the early stages of recovery. Hypertransfusion of the irradiated, protected mice eliminates most of the stimulus to erythroid differentiation and prevents the increase in nucleoside deaminase. The present studies indicate that this enzyme is present in a differentiated red cell precursor not found in the normal stem cell population. (auth)

2803 CHROMOSOME ABERRATION PERSISTENCE AND IN VIVO–IN VITRO DOSE RESPONSES IN PIG LEUKOCYTES FOLLOWING EXPOSURE TO FISSION NEUTRONS. Mailhes, J. P. Jr. Knoxville, Tenn.; Univ. of Tennessee (1972). 125p. University Microfilms Order No. 72-27,485.

Thesis.

The rate of induction of chromosome aberrations in pig lymphocytes following 100, 200, 300, and 400 rads of fission neutrons administered in vivo and in vitro was determined. The data from each exposure method were tested for goodness of fit of linear and quadratic models. Numbers of acentric fragments, numbers of rings plus numbers of dicentrics, and the sum of the frequencies of aberration types were well explained by a linear model. A statistical comparison between exposure methods, using doses measured in air, indicated a significantly higher aberration index was found following an in vitro exposure of the animal's blood than was produced by exposing the entire animal. Equations were developed that permitted the prediction of in vivo damage from the in vitro aberration coefficient. It is concluded that different aberration coefficients will be found in blood sampled from pigs at different

postexposure intervals. The kinetics of aberration persistence should therefore be considered when lymphocyte aberrations are employed as biological dosimeters. (Diss. Abstr. Int., B)

2804 DIFFERENTIAL EFFECTS OF X RAYS ON 19S AND 7S PRIMARY ANTIBODY RESPONSES. Ohba, Shozo (Kanazawa Univ., Japan). Kanazawa Irigaku Sosho; 89: 39-50(Jun 1971). (In Japanese).

Experiments were carried out on rabbits and guinea pigs for the purpose of clarifying the effects of whose body x-irradiation one day before or after antigen administration upon 19 S and 7 S primary antibody responses. In rabbits, saline extract of guinea pig kidney (F-antigen), isophile antigen of goat red cell (I-antigen), alum-precipitated hen egg albumin, typhoid OH vaccine or typhoid O vaccine, and in guinea pigs, hen egg albumin (HEA) were used as antigens. The dose of x-rays in rabbits and guinea pigs was 500 R and 200 to 250 R, respectively. The sequential appearance of 19 S and 7 S antibodies was observed in the animals injected with all the antigens but typhoid O by which only 19 S was produced. In rabbits, x-ray administration before F-antigen treatment delayed the onset of 7 S formation, slowed the kinetics and reduced the peak titer, while 19 S formation was observed to be less affected. X-ray administration before I-antigen injection prevented the development of 19 S and 7 S responses. When x-irradiation was given prior to administration of alum-precipitated HEA or typhoid OH vaccine, prolongation of the latent period of 19 S and 7 S formation and reduced peak titer were observed. Delay of the onset and the lowered peak titer of 19 S to typhoid O was also demonstrated. In guinea pigs, delay of 19 S and 7 S formation, slowdown of the kinetics and reduction of the peak titers were observed to occur by x-ray prior to HEA administration. These changes of antibody formation were smaller in animals treated with HEA in FCA than in animals treated with HEA in saline. Moreover, it was demonstrated that production of 7 S_2 was more radiosensitive than that of 7 S_1. By administering x-rays after antigen administration, somewhat slower kinetics of 19 S formation and late elevated antibody titer were often demonstrated. (Japan)

2805 MARMOSET AS AN ANIMAL MODEL FOR TERATOLOGICAL RESEARCH. Poswillo, D. E.; Hamilton, W. J.; Sopher, D. (Royal Coll. of Surgeons of England, London). Nature (London); 239: No. 5373, 460-2(20 Oct 1972).

It is stated that there is an urgent need for the provision of a suitable near-human model for research in teratology. The marmoset Callithrix jacchus is a readily available monkey, inexpensive to purchase and house, easy to manage on a human diet, breeds easily, and appears to parallel the teratogenic sensitivity of humans. In order to determine the sensitivity of this primate equivalent doses of agents known to interfere with human embryonic development were administered; these agents included irradiation, androgenic hormones, and thalidomide. With regard to irradiation 25 day pregnant marmosets were exposed for a few minutes to therapeutic deep x-rays from apparatus operating at 200 kV and 10 mA, delivering 250 R to the uterus through the anterior abdominal wall, the remainder of the body being shielded by Pb protection screens. Irradiation produced, at this stage of embryogenesis, craniorachisis, limb anomalies, cleft palate, micrognathia, and abnormalities of the auricle. It is concluded that the marmoset is amongst the most suitable non-human primate models available for teratological studies, although it has not yet been established that its use for the testing of new or suspected drugs may not reveal all the hazards to man from these sources. (UK)

2806 RADIOPROTECTION OF MICE BY ORAL ADMINISTRATION OF 2-AMINOETHANETHIOSULFURIC ACID. Takagi, Y.; Shikita, M.; Akaboshi, S. (National Inst. of Radiological Sciences, Chiba, Japan). Chem. Pharm. Bull. (Tokyo); 20: No. 6, 1102-4(Jun 1972).

The radioprotective action of 2-aminoethanethiosulfuric acid and related compounds was examined in mice after the compounds were injected intraperitoneally into the animals. 2-Aminoethanethiosulfuric acid gave a radioprotective effect comparable to that given by cysteamine, if a large amount of the compound was injected. 2-Aminoethanethiosulfuric acid was given orally to mice in a dose of 0.6 to 0.7 LD_{50} 15 to 30 minutes prior to irradiation. It was noted that the increase in the x-ray dose counteracted the radioactive effectiveness of the compound. Seemingly, 2-aminoethanethiosulfuric acid was slightly more effective than cysteamine. In the case of mice irradiated with a total dose of 700 R of x ray, the effectiveness of the 2-aminoethanethiosulfuric acid continued for more than 6 hours when it was given orally, while the effectiveness of intraperitoneally injected compound ended in 1 hour. S-sulfocysteine was orally or intraperitoneally given to mice prior to irradiation with 700 R of x ray and the duration of the radioprotective action of the compound was compared with the duration of the effectiveness of cysteine hydrochloride which was injected intraperitoneally. The radioprotective effects of S-sulfocysteine and cysteine both faded away in 1 hour after administration. The radiation protective effect of the compound, however, was not observed in the animals which received 900R radiation. (Japan)

2807 ELECTRON MICROSCOPIC STUDY ON THE ABNORMAL DEVELOPMENT OF THE EMBRYONIC HEART INDUCED BY FAST NEUTRON IRRADIATION. Satow, Yukio (Hiroshima Univ.). Med. J. Hiroshima Univ.; 19: No. 1-2, 21-40(Feb 1971). (In Japanese).

Rats were exposed to a single dose of 130 rads of whole-body irradiation 8 days after conception and embryos were removed at various stages for studies on abnormally developing embryonic cells. In the embryonic dermal cells, at 1 hour after irradiation, dilatation of the nuclear envelope, endoplasmic reticulum (ER) and mitochondria were observed. After 2 to 3 hours, vacuoles were produced around the dense body, mitochondria, ER and nuclear envelopment increased. At 6 hours after irradiation lysosomes 3-5μ in size were frequently seen, which contained vacuoles, degenerated mitochondria, and dense materials and showed positive acid phosphatase activity by histochemical techniques. The lysosomes seen in our experiments played some roles in differentiation and morphogenesis; that is, cell death due to the large lysosomes or residual bodies led to decrease of the cells. In order to compare the effects of ionizing irradiation with those of other teratogens, the pregnant rats were treated with actinomycin D(AD) and trypan blue (TB) 8 days after conception. In the neutron irradiated group, the decrease of cells and the disorders of genetic regulation of the developmental process due to direct or indirect effects are presumed to be the causal factors of cardiovascular anomalies. (Japan)

2808 LOCAL INFLUENCE OF THE VASOACTIVE EFFECT OF HIGH CALCIUM AND HYDROGEN ION CONCENTRATIONS ON THE DEPILATORY ACTION OF X-RAYS IN YOUNG MICE. Pospisil, M.; Netikova, J.; Vacek, A. (Inst. of Biophysics, Brno). Physiol. Bohemoslov.; 21: No. 2, 207-12(1972).

The effect of the subcutaneous administration of $CaCl_2$ and of high hydrogen ion concentrations in NaCl and KCl solutions on the epilatory action of whole-body x irradiation in young C57Bl mice was studied. $CaCl_2$ and high hydrogen ion concentrations in NaCl solution (pH 2) provided a high degree of protection when administered up to 5 minutes prior to irradiation. High hydrogen ion concentrations enhanced the protective effect of potassium ions, which were also observed at physiological pH values. Post-irradiation administration of the given solutions did not modify the epilatory action of radiation. The protective effects of the ions employed were accompanied by a drop in subcutaneous oxygen tension at the site of injection, evidently owing to local vasoconstriction. It can be presumed that the local effect on tissue oxygen tension participated in the mechanism of the radioprotective effects observed. (auth)

2809 INFLUENCE OF IONIZING IRRADIATION ON THE METABOLISM OF CATECHOLAMINE. Stepanovic, S. Belgrade; Faculty of Natural Sciences and Mathematics (1970). (In Serbo-Croatian).

Thesis.

Catecholamines are neurohumoral transmitters of stimuli in the central and autonomic nervous systems. The maintenance of physiologic processes in the central and autonomic nervous systems presupposes an intact metabolism of these substances. The author shows that ionizing irradiation causes an impairment in the metabolism of these biogenic amines. A lowering of the depot of catecholamine in the body of the irradiated animal, which has been proved by the author, depends on the irradiation dose applied. By following up the dynamics of these changes, it was established that smaller doses of irradiation cause reversible changes in the metabolism of catecholamine, while after supralethal doses it is no more possible to set up a depot of catecholamine. The author also investigated the metabolizing of catecholamine precursors in the irradiated organism. It has been shown that in the organism of the animal irradiated with a smaller dose of x rays, tyrosine and l-DOPA metabolize up to noradrenalin. In the body of an animal irradiated with large doses of x rays, the metabolizing of catecholamine precursors is impossible. Analogous data in relation to the irradiation dose was received by the author when investigating the process of adopting and depositing an exogenously applied noradrenalin. It has also been established that certain inhibitors of biosynthesis of catecholamine (e.g. alpha-methyl-DOPA) still exhibit an effect in the organism of the animal irradiated with a smaller x ray dose, but do not act after a larger dose. In contrast, other types of inhibitors (alpha-methyl-tyrosine) exhibit their effect in sublethal and supralethal irradiated animals. Such a finding suggests that the action of tyrosine-hydroxylase as the limitation factors of the biosynthesis of catecholamine is maintained also in the irradiated organism.

Finally, the author proved that cysteamine, the well-known radioprotective substance, exhibits a certain protective effect also on the level of the described biochemical lesion. (Bull. Sci., Sect. A.)

2810 ADRENOCORTICOID CONTENT AND INTESTINAL CRYPT CELL POPULATION KINETICS AFTER RESECTION AND X IRRADIATION. Poulakos, Lawrence. Iowa City, Iowa; Univ. of Iowa (1972). 72p. University Microfilms Order No. 72-26,725.

Thesis.

Following lethal exposures of whole-body x irradiation, there is a biphasic increase in the activity of the rat pituitary-adrenocortical system. A "first corticosteroid increase" occurs within minutes to hours after irradiation, and a "second corticosteroid increase" occurs 2 to 4 days later. Changes in the small intestine were postulated as the stressors inducing the second increase and for this reason the term "intestinal corticosteroid increase" is used. The purposes of a part of this study were (i) to determine if x irradiation of only the small intestine could initiate and sustain the second corticosteroid increase in a manner similar to that seen after whole-body irradiation, (ii) to determine whether resection prior to whole-body x irradiation could modify the second corticosteroid increase, and if so, (iii) to determine if any modification of the second corticosteroid increase could be explained by changes in the epithelial cell population of the residual small intestine. This study is the first to show a direct relation between radiation-induced intestinal injury and the second corticosteroid increase. Exposures of only the exteriorized small intestine initiated and sustained an increase in plasma corticosteroids from 1 to 5 days after 1000 R in a manner similar to that noted after whole-body irradiation. Three days after irradiation of only the gut, the plasma and adrenal corticosteroid content were found to be exposure-dependent and exposure-independent within a range commonly found after whole-body irradiation. Resections of 50 or 80% of the small intestine 10 to 11 days prior to 750 R whole-body x irradiation did not modify the second corticosteroid increase. The lack of modification may have been due to an increase in the residual intestinal absorptive area caused by compensatory changes in the intestinal crypt cell population. Thus, the radioprotective effect seen by others with resection prior to irradiation of only the gut may be associated only with that particular irradiation procedure. Since the plasma and adrenal corticosteroid content were already normal 10 to 11 days after 50 or 80% intestinal resections, an investigation was undertaken to determine how soon after such massive surgery the corticosteroid levels returned to normal. Characteristics of the crypt cell population of the residual intestine were also studied. At 3 days after surgery, corticosteroid levels in both resected groups were increased compared to control and were in direct relation to the amount of intestine removed. However, only after 80% resection were the increases significantly different from control values. By 9 days the corticosteroid levels in both resected groups had returned to control values. Elevated corticosteroid levels at 3 days after resection may have been due to surgical stress and/or altered intestinal function. At 3 days after surgery, there were definite changes in the values for some crypt cell kinetic parameters of the residual intestine compared to control in the 80% resection group only. Increases occurred in the numbers of cells, labeled cells, and mitotic figures per crypt section. These values were increased in both resected groups at 9 days. At neither time were there any marked changes in the percentage of labeled cells. The compensatory changes in the crypt cell population were in direct relation to the size of resection and time after resection. From comparisons with published data, it is suggested that compensatory changes begin a few days after resection and thereafter the increased crypt cell population remains relatively unchanged. The onset and progression of recovery in a 2.5 cm segment of rat ileum given 1000 R x radiation and the influence on adjacent but shielded segments were also studied. At 7, 14, 17, 21, 28, and 35 days after irradiation, the irradiated or sham-irradiated segment and segments of shielded intestine located 5 cm and 10 cm distally were prepared for radioautography. At each time sampled, the numbers of cells, labeled cells, and mitotic figures per crypt section in both the irradiated and 5 cm distal segments were greater than in their respective control segments. The 10 cm distal values were not different from their control values. The difference in values between treated and control animals decreased with time after irradiation while the difference in values between irradiated and distal segments was less marked as the distance from the irradiation site increased. The compensatory changes in the crypt cell population that occur in shielded intestine following segmental intestinal irradiation are similar to those that occur in residual intestine following resection. It is suggested that the functional status of the remaining intestine influences crypt cell population kinetics. (Diss. Abstr. Int., B)

2811 RADIATION DOSE-TIME RELATIONS FOR INDUCTION OF OSTEOSARCOMA IN MICE AND DOGS AND THEIR BEARING ON MAXIMAL PERMISSIBLE BURDEN OF ^{90}Sr IN MAN. Blair, H. A. (Univ. of Rochester, N. Y.). Health Phys.; 23: No. 6, 759-65(Dec 1972).

A method is discussed for deriving latent periods when survival times and quantities of injected carcinogenic nuclides are the only data available. It is proposed with examples from the dog and the mouse that the toxicities with respect to bone cancer production by ^{226}Ra, ^{239}Pu, and ^{90}Sr are related better on the basis of either radiation dose or injected dose causing cancer in equal times than on total incidence over an indefinite time. On this basis the toxicity of ^{226}Ra per injected dose probably does not exceed 40 times that of ^{90}Sr in both dog and mouse. This ratio in contrast o 200 used by Marinelli in calculating the Maximal Permissible Burden of ^{90}Sr in man lowers his value from 9.5 to 1.9 μCi. (auth)

2812 ABILITY OF THYMUS AND BONE MARROW CELLS FROM IMMUNIZED DONORS TO RESTORE ANTIBODY FORMATION TO BSA IN IRRADIATED MICE. Handzel, Z. T.; Frensdorff, A.; Buchner, V. C.; Witz, I. P. (Tel Aviv Univ., Israel). Immunology; 23: No. 4, 651-4(Oct 1972).

Experiments were made to determine whether the frequency of thymic or bone marrow memory cells of a given specificity would differ in immunized mice, compared with non-immunized ones. Mice were lethally irradiated with a single whole-body x-ray dose of 820 rad. The irradiated mice were then reconstituted with thymus and bone marrow cells obtained from normal or primed mice, challenged with antigen and the antibodies determined. The response was in the following order. The group which had been reconstituted with thymus and bone marrow cells from immunized donors (mean 544 μg/ml). Those which had received thymus cells from immunized donors and bone marrow cells from non-immunized ones (mean 213 μg/ml). Those which had received bone marrow cells from immunized donors, and thymus cells from non-immunized ones (mean 22 μg/ml). Those which had received cells from non-immunized donors only (mean 50 μg/ml). (UK)

2813 MODIFICATION OF UNSATURATED IRON BINDING CAPACITY AFTER WHOLE-BODY X IRRADIATION OF RATS. Stanculescu, V.; Ciubotaru-Bordeianu, A.; Herscovici, M.; Racoveanu, N.; Iliescu, T. Rev. Roum. Biochim.; 8: No. 4, 329-33(1971).

The experiment was performed on white rats irradiated with x rays (doses ranging from 5 to 900 R); the variation of UIBC depending on the dose of exposure and on time (2 hours to 7 days) was followed. The experimental results 24 hours after irradiation showed a statistically insignificant decrease of UIBC at 50 and 100 R, a very marked one at 300 R, and values constantly within the same low limits at 600 and 900 R. In time, the variation of UIBC registers an increase of 20% 2 hours after irradiation, a strong decrease after one day which is constant up to the 4th day, after which a recovery towards the normal value is observed, the latter being reached on the 7th day. (auth)

2814 EARLY LYMPHOPENIA AS BIOLOGICAL INDICATOR OF POSTIRRADIATION RESPONSE. Zak, M.; Dienstbier, Z.; Rezny, Z. (Charles Univ., Prague). Strahlentherapie; 144: No. 1, 60-9(Jul 1972).

Results of changes in lymphocyte and leukocyte counts after external x irradiation of mice are presented in this study. The count of lymphocytes was estimated from differential calculation and also from their changes of absolute counts. Dependence upon the time after exposure and upon the dose of irradiation was determined. The time after exposure was one, three, five, 24, 27, 29, 48, and 53 hours. Dose of irradiation was 25, 50, 100, and 600 R. It can be concluded that the changes found in the count of leukocytes in individual time intervals after irradiation with various doses are mostly of no statistical significance. The changes in absolute counts of lymphocytes in relation to the dose of radiation and in relation to the time after exposure are suitably differentiated and the significance between the groups is quite good. The highest frequency of significant values between individual groups which were irradiated with different doses was found in relative counts of lymphocytes. It is concluded that the absolute and relative counts of lymphocytes are a good parameter of an early biological detection of ionizing radiation. (auth)

2815 EXPERIMENTAL X RAY-INDUCED TERATOLOGY AND THE GENERAL IMPLICATIONS. Ostertag, B. (Univ., Tuebingen, Ger.); Heinzmann, U. Aerztl. Forsch.; 26: No. 3, 87-95(1972). (In German).

After a short survey of the experimental x ray induced teratology, the general problems and the effects of hemilateral exposure of the pregnant mouse and the irradiation effect during the early stage of development of fetuses are discussed. The effects of irradiation on the 11th day of gestation on anatomic changes of the

nervous system are described. Another main part reports the malformation of the rhinencephalon and the optic system after irradiation on the 8th day of gestation. After the irradiation true meningeal blastomas were observed. As yet nothing definite is known about the further development of intracerebral hyperplasias. (GF)

2816 PRODUCTION OF METASTASES BY A PRIMARY TUMOUR IRRADIATED UNDER AEROBIC AND ANAEROBIC CONDITIONS IN VIVO. Van Den Brenk, H. A. S.; Moore, V.; Sharpington, C.; Orton, C. (St. Thomas' Hospital, London). Brit. J. Cancer; 26: No. 5, 402(Oct 1972).

The effect of single dose local x-irradiation (750 to 4000 rad) of a rapidly metastasizing sarcoma in the leg of the rat was measured in terms of regression of the primary tumor and growth of metastases produced in lymph nodes and lungs by dissemination occurring after irradiation of the primary tumor. These effects on rats which had been irradiated while breathing air were compared with rats breathing 10% O_2/90% N_2 with a tourniquet applied proximal to the tumor to arrest blood flow during irradiation. Tourniquet anoxia increased radioresistance of growth of primary tumor by (OER) factors of 2.9 to 3.3. Corresponding factors for inhibition of growth of metastases in abdominal lymph nodes, and for the reduction in incidence of lung metastases produced by single tumor cells, were 2.7 and 2.4 respectively. It was suggested that this tumor was radiobiologically well oxygenated when it was irradiated in a poorly vascularized stage of growth where tumor necrosis had developed. (auth)

Invertebrates

2817 (AEC-tr-7362, pp 225-30) INFLUENCE OF X IRRADIATION ON THE HEMOLYMPH AND PHAGOCYTOSIS IN LARVAE OF THE CODLING MOTH LASPEYRESIA POMONELLA. Pristavko, V. P.; Orgel, G. S. (Ukrainian Scientific Research Inst. of Plant Protection, Kiev). Translated from Radiobiologiya; 12: No. 2, 307-10(1972).

The change in the total number of hemocytes, the ratio among their individual types, the activity of phagocytosis of BCG vaccine in codling moth larvae irradiated with x rays at doses of 10 to 100 kR, were studied. Irradiation causes a decrease in the total number of hemocytes and inhibits their phagocytic activity. No morphological changes and disruptions in the ratio among the types of cells of the hemolymph were detected under the influence of irradiation. (tr-auth)

2818 (AEC-tr-7362, pp 235-7) INFLUENCE OF IONIZING IRRADIATION ON THE SEXUAL STERILIZATION OF THE LEOPARD MOTH. Polozhentsev, P. A.; Khvatova, L. P. Translated from Radiobiologiya; 12: No. 2, 313-15(1972).

Irradiation of pupae of male and female leopard moths with γ rays at doses from 2500 to 6000 R was tested. Complete sterilization of the pupae begins in the case of irradiation at a dose of 4000 R. The moths obtained from the pupae irradiated at doses up to 4000 R retain their activity of movement, and the males actively seek out females and copulate. No embryos develop from the eggs laid by individuals irradiated at doses above 4000 R. (tr-auth)

2819 (KURRI-TR-87, pp 1-4) EFFECTS OF FAST NEUTRONS AND ^{60}Co γ-RAYS ON ARTEMIA. Iwasaki, Tamiko. 1971. (In Japanese).

In alteration factors of radiation injury.

The effects on Artemia dry eggs of a single exposure to 2 MeV fast neutrons were compared with those of exposure to ^{60}Co γ-ray irradiation. Sigmoidal hatchability curves were found for irradiation with γ-rays and neutrons. The relative biological effectiveness (RBE) of fast neutrons with respect to γ-rays was 1.4 for 50% hatchability of the eggs. The RBE of fast neutrons versus γ-rays for 50% survival at one day after hatching was 2.2, 2.8 at 2 days and 4.8 at 3 days, respectively. Irradiation with fast neutrons produced severe chromosomal abnormalities and led to a depression in mitotic activity. On the basis of the cytological observations, the RBE of fast neutrons was about 2 with reference to γ-rays. (auth)

2820 MUTATION INDUCTION BY X-RAYS IN SPERMATOGONIA OF DROSOPHILA. Oftedal, Per (Norsk Hydro's Inst. for Cancer Research, Oslo). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 310-11(Jun 1972).

From 3rd L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

Synchronous embryos of Drosophila were exposed to 140 rads and the yield of sex-linked recessive lethals was found to oscillate with a period similar to the mitotic cycle length at that age. Results are presented by means of graphs. By comparing the lethals recovered from each male, it could be shown that in the peaks, in addition to the higher sensitivity to mutation induction, there was also a higher sensitivity to cell killing. This was demonstrated by the fact that clusters of identical mutations were more frequent in the peaks, indicating that the surviving spermatogonial population available for sampling was smaller. (H.L.W.)

2821 INTRODUCTION TO THE DISCUSSION ON MITOTIC DELAY. Evans, H. J. (Western General Hospital, Edinburgh). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 319-22(Jun 1972).

From 3rd L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

A review of radioinduced mitotic delay in sea urchin eggs and sperm is presented. Mitotic delay was regarded as a delay in the progression of cells from interphase into mitosis and was estimated by recording the changes in relative frequency of cells in mitosis at various times after a radiation exposure. The induced increase in the time interval between fertilization and the consequent first cleavage was referred to as cleavage delay. The term division delay has been used in studies on radiation effects on cell populations and is defined as the time interval required to revert back to a pattern of exponential growth. Studies on x-irradiated enucleated sea urchin eggs were conducted to determine the relative importance of nuclear and cytoplasmic damage in mitotic delay. Other studies on uv- and x-irradiated sea urchin eggs showed that cleavage delay involved damage to nucleic acids and nucleoproteins. (H.L.W.)

2822 AGE AT PUPATION AND POPULATION EFFECTS ON SURVIVAL OF ADULTS OF THE FLOUR BEETLE TRIBOLIUM AFTER X-IRRADIATION. Soliman, M. H. (Univ. of Alberta, Edmonton). Int. J. Radiat. Biol.: 22: No. 5, 425-30(Nov 1972).

The effect of exposure to a single dose of x-irradiation (10 kR) on 2nd-day pupae of eight populations of Tribolium castaneum and six populations of T. confusum, all with different geographical backgrounds, was studied at 33°C and 70% R.H. The mean survival-time after irradiation was different among T. castaneum populations, with a range of 8.05 days (Kenya) to 5.48 days (France). T. confusum did not show any significant difference among populations, which ranged from 6.38 days (Kenya) to 5.40 days (Germany). The overall difference between the two species means (7.25 days for T. castaneum and 5.70 days for T. confusum) was highly significant. The overall survival patterns of the two species were similar. However, after 5 days of adult emergence, 65% of T. castaneum and only 27% of T. confusum still survived. The effect of age at pupation was investigated only on T. castaneum. Intermediate pupae from the total pupation period yielded adults that survived longer than those from early or late pupae. (UK)

2823 CYTOGENETICS OF TICKS (ACARI: IXODOIDEA). 9. CHROMOSOMES OF RHIPICEPHALUS SANGUINEUS (LATREILLE) AND EFFECTS OF GAMMA RADIATION ON SPERMATOGENESIS. Oliver, J. H.; Osburn, R. L.; Roberts, J. R. Jr. (Georgia Southern College, Statesboro). J. Parasitol.; 58: No. 4, 824-7(Aug 1972).

The normal chromosome complement in Rhipicephalus sanguineus consists of 20 + X and 20 + XX in males and females, respectively. Chromosome dynamics are discussed. Experimental male ticks were irradiated at 0.5, 1.0, 2.0, 3.0, 4.0, 8.0, and 16.0 krads prior to feeding. Testicular squashes were made and chromosomal aberrations observed. At lower levels of radiation (0.5 to 4.0 krads), the major observable abnormality was chromosomal bridges, while higher levels (8.0 and 16.0 krads) produced fragmentation and chromosome ring formation. Aberrations were present at all treatment levels, but increased in severity as radiation dose levels increased. Hatchability studies showed reduced hatch at all treatment levels with no hatch above 1.0 krad. Some radiorecovery occurred at lower doses (0.5 to 3.0 krads), but permanent sterility resulted at and above 4.0-krad level. (auth)

2824 EXPERIMENTAL VERIFICATION OF EFFECTIVENESS OF RADIATION VACCINE AGAINST CATTLE DICTYOCAULOSIS. Pokorna, J. Veterinarstvi; 22: No. 1, 16-19(1972). (In Czech).

The results are presented of experiments carried out in 1971 with active immunization of cattle against dictyocaulosis using irradiated larvae as vaccine. The vaccine was prepared from the larval suspension of stage III Dictyocaulus viviparus by x-irradiation. The double administration of the irradiated vaccine to the experimental animals resulted in a highly significant protection of the immunized animals against subsequent massive invasion by nonirradiated larvae. The similar dose of larvae administered to the control group resulted in grave dictyocaulosis. The evaluation of the effect of the vaccine was based on clinical investigations of the health conditions of the animals, the excretion of larvae in the faeces, and on the pathological and anatomical findings yielded by autopsy. The results pertaining to the experi-

mental and control animals showed statistically significant differences. (NSA of Czech.)

2825 ACTION OF ENZYMES RELEASED BY DAMAGED LYSOSOMES. Allison, A. C.; Paton, Gillian (Medical Research Council, Harrow, Eng.). Curr. Top. Radiat. Res. Quart.; 7: No. 3, 345-6(Jun 1972).

From third L. H. Gray memorial conference on radiation effects and the mitotic cycle; Manchester, England (5 Jan 1971). See CONF-710120.

A brief review is presented of studies on chromosome breaks induced by DNAase from lysosomes. Chromosome aberrations induced by endonucleases from the pancreas, lysosomes, and Escherichia coli are also discussed. A discussion is presented of the role of lysosomal nucleases in chromosome aberrations induced by alpha particles and x radiation. (H.L.W.)

2826 INFECTIVITY AND DEVELOPMENT OF X-IRRADIATED METACERCARIAE OF LEUCOCHLORIDIOMORPHA CONSTANTIAE (TREMATODA) IN THE CHICK AND ON THE CHORIOALLANTOIS. Fried, Bernard; Davis, J. E. (Lafayette Coll., Easton, Pa.). Trans. Amer. Microsc. Soc.; 91: No. 2, 208-12(Apr 1972).

Infectivity and development of L. constantiae metacercariae x-irradiated at 500 to 20,000 R were studied in the bursa of Fabricius of the chick and on the chorioallantois. X-irradiation significantly affected infectivity in the chick and on the chorioallantois. Control flukes and those irradiated up to 2000 R were ovigerous. Egg development was suppressed at 3000 R and postmetacercarial development did not occur at 5000 to 20,000 R. Radiation did not affect pairing or clustering of worms in the bursa or on the chorioallantois. (auth)

Radionuclide Effects (Internal Source)

Man

Refer also to abstracts 2760, 2762, and 2836.

2827 (CEA-CONF-2094) COMPARATIVE STUDY OF TWO METHODS OF ESTIMATING HUMAN INTERNAL EXPOSURE HAZARDS RESULTING FROM THE INGESTION OF SEA FOODSTUFFS. Bittel, R. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 5p. (CONF-720503-5). Dep. NTIS (U. S. Sales Only).

From 2nd European congress on radiation protection; Budapest, Hungary (3 May 1972).

On the basis of several typical situations, a discussion is presented on the advantages and drawbacks of two methods of estimating human internal exposure hazards resulting from the ingestion of contaminated seafoods, i.e., the concentration factor and the specific activity methods. The comparison was carried out for limiting levels of fission and activation products in marine water to select the suitable method according to the radionuclides considered. (auth)

2828 FEASIBILITY OF ESTIMATING THE EXPOSURE OF URANIUM MINING PERSONNEL TO SHORT-LIVED ^{222}Rn DECAY PRODUCTS BY DETERMINING ^{210}Po IN HAIR. Solnicka, H.; Bischof, R. (Inst. of Occupational Hygiene in Uranium Industry, Pribram, Czech.). Prac. Lek.; 23: No. 4, 110-12(May 1971). (In Czech).

The mean specific activity of ^{210}Po detected in hair of a sample of 17 men who had not been occupationally exposed to short-lived ^{222}Rn decay products was determined to be 0.048 ± 0.34 pCi/g. This confirmed that, under normal conditions, determination of ^{210}Po in hair could be used to detect and assess the occupational exposure of uranium mining personnel to short-lived products of ^{222}Rn in an environment where the concentration of these products was considerably lower than the maximum permissible concentration, the latter corresponding to a total energy of alpha radiation of 4×10^4 MeV/litre. (NSA of Czech.)

2829 SOURCES AND RADIATION HYGIENE OF TRITIUM. Carach, J.; Cechvala, L. (Inst. of Hygiene and Epidemiology, Bratislava). Prac. Lek.; 23: No. 4, 120-5(May 1971). (In Slovak).

The sources of tritium are increasing in Czechoslovakia, owing to the construction of both heavy water and light water reactors. Occurrence and sources of natural and artificial tritium are described, and the toxicology of tritium and its compounds is discussed. Hazards resulting from tritium leakage from reactors, and inspection and measurement methods are dealt with in detail. Basic protection methods to be applied in practice are presented, i.e., workplace isolation, personnel monitoring, and decontamination methods and equipment. Monitoring of tritium in fallout and in milk and concentration determinations in reactor discharge and surface waters are recommended as a means of environmental monitoring in the vicinity of nuclear installations. (NSA of Czech.)

2830 HUMAN FETAL RADIATION DOSE FROM ^{59}Fe ADMINISTERED TO THE MOTHER DURING PREGNANCY. Dyer, N. C. Nashville; Vanderbilt Univ. (1972). 228p. University Microfilms Order No. 72-26,096.

Thesis.

Of all the segments in the population exposed to ionizing radiation, the most sensitive age group is the developing embryo. Occasionally, pregnant women are given diagnostic or therapeutic amounts of radionuclides, deliberately or, more usually, inadvertently. To correctly assess hazards from the exposure to ionizing radiation, the radiation absorbed dose to the fetus must be known. Calculations of the radiation dose to the fetus and the critical fetal organs were made for the radioisotope, ^{59}Fe. The critical fetal organs and the other necessary fetal parameters for the dose calculations were determined for the first half of the gestational period by studies on women receiving therapeutic abortions. The women were given the radiotracer ^{59}Fe approximately eighteen hours before the operation. After the operation, the ^{59}Fe transferred to the fetus plus the distribution of transferred ^{59}Fe within the fetus were determined. Iron exchange during the last half of the gestational period was studied in normal pregnant women using the stable tracer, ^{58}Fe. The stable tracer studies provided the maternal iron utilization parameters and data on the transfer of the iron tracer to the infant's circulating blood at birth. However, due to the lack of infant autopsy data, the distribution of the transferred tracer iron within the infant could not be determined directly by the stable tracer studies. Iron transfer studies were done on late gestational stage ewes where the distribution of the transferred iron within the fetal lamb was determined. By using the transfer to the blood circulations as the normalization between lamb and human infant, the fetal lamb data were extrapolated to the human infant. The self-dose from the isotope in the fetus or critical fetal organs plus the penetrating radiation dose from the mother were considered in the dose calculations. Because the human fetus is a rapidly growing organism, the absorbed dose calculations must consider the masses of the fetus and fetal organs as being time dependent. Therefore, the equations for the absorbed radiation doses to the fetus and its critical organs contain time dependent growth terms as well as ^{59}Fe clearance data. The dose contribution from the mother to the fetus was assumed to terminate at the birth of the infant. Over the gestational ages from 9 to 35 weeks, total fetal dose from ^{59}Fe was calculated to be 37 ± 4 rads/mCi with no apparent variation with gestational age. The critical fetal organs for ^{59}Fe were the liver and spleen. The fetal liver and spleen doses were calculated to be 347 ± 64 rads/mCi and 87 ± 24 rads/mCi, respectively. Also, there were no apparent correlations between gestational age at administration and the fetal liver and spleen absorbed doses from ^{59}Fe. The amount of radioactive ^{59}Fe is that amount administered intravenously to the mother. The calculations were integrated over the time from administration to ten half-lives of ^{59}Fe. The formulations and considerations needed for the fetal and fetal organ dose calculations are presented. The $^{58}Fe(n,p)^{58}Mn$ reaction caused by 14.4-MeV neutrons was investigated for use in the stable tracer studies, but the reaction proved to be too insensitive. Gamma-ray singles spectra in the decay of ^{58}Mn to ^{58}Fe were measured with a Ge(Li) detector. Beta groups of 3.8 ± 0.1 (63.5%/decay) and 5.9 ± 0.1 (11.5%/decay) MeV were measured with a plastic scintillator. Sixteen γ-transitions were observed, 10 for the first time. Twelve were fitted into levels at 810.73, 2^+; 1674.71, 2^+; 2134.0, 3^+; 2600.7, 3399.7, 3442.9; and 3634, 2^+, keV. The half-life was found to be 65.3 ± 0.7 s. The (n,p) cross sections of ^{56}Fe and ^{58}Fe for 14.4 MeV neutrons were measured to be 109 ± 10 and 11.4 ± 1.0 millibarns, respectively. (Diss. Abstr. Int., B)

2831 RADIOACTIVE FISSION PRODUCTS AND THEIR SIGNIFICANCE IN THE DIET. Berner, R. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerelingen, Switzerland). Mitt. Geb. Lebensmittelunters. Hyg.; 60: No. 5, 403-9(1970). (In German).

The main hazard from fallout of radioactive substances consists in external irradiation. Only milk and well water will entail hazards from uptake. The only nuclide that is important in a case of disaster is ^{131}I. Possible adverse effects from ^{90}Sr and ^{137}Cs have so far been greatly exaggerated. These rarely cause acute damage and genetic changes have not been observed. (EURATOM)

2832 THICKNESS OF BRONCHIAL EPITHELIUM WITH RELATION TO EXPOSURE TO RADON. Gastineau, R. M. (Dept. of the Army, Washington, D. C.); Walsh, P. J.; Underwood, N. Health Phys.; 23: No. 6, 857-60(Dec 1972).

The basal cells are thought to be the primary target for carcinogenesis from the inhalation of radon daughters in uranium

miners. The depths of the basal cells of normal bronchia epithelium were measured for the purpose of using the data in describing the proportion of basal cells within the range of alpha radiation from inhaled radon and radon daughters. In over two-thirds of the epithelium of the lobar and segmental bronchi the basal cells are within the range of ^{214}Po alpha particles and in one-fifth of the same epithelium the basal cells are within the range of both ^{218}Po alpha particles assuming the radioactive substances are located on the surface of a 7 μ thick layer of mucus. It is postulated that the presence of thin areas of metaplasia in the bronchia epithelium could result in the occurrence of bronchogenic cancer in main stem bronchi which may explain the increased incidence of lung cancer in miners who smoke. Readily soluble radioactive substances which could penetrate rapidly to the base of the cilia may also result in a higher proportion of radiated cells than calculated. (auth)

Animals

Refer also to abstract 2845.

2833 EFFECTS OF ^{131}I AND ^{125}I ON MOUSE AND RAT THYROID. Jongejan, W. J.; van Putten, L. M. (National Institution of Scientific Education, Rotterdam). Int. J. Radiat. Biol.; 22: No. 5, 489-99(Nov 1972).

The hypothesis that ^{125}I exerts an extra nuclear effect on the thyroid was studied experimentally in rodents. Doses of ^{125}I and ^{131}I, producing a similar effect on the structure of the thyroid gland, on the thyroxine-level in the serum, and on the capacity of the thyroid to concentrate radioactive iodine, were compared. No specific effect of the ^{125}I on hormonal levels was observed. The hypothesis of an extra nuclear effect was therefore not confirmed. (auth)

Nuclide Kinetics and Toxicology

2834 (CONF-720708-11) CONTRIBUTIONS FROM THE ALPHA EMITTER, ^{210}Po, TO THE NATURAL RADIATION ENVIRONMENT OF THE MARINE ORGANISMS. Folsom, T. R. (Scripps Institution of Oceanography, La Jolla, Calif.); Beasley, T. M. (Washington Univ., Seattle). [nd]. 10p. (SM-158/41). Dep. NTIS.

From Symposium on the interaction of radioactive contaminants with the constituents of the marine environment; Seattle, WA. (10 Jul 1972).

In describing the natural background radiations in the marine environment, emphasis in the past was given to contributions from potassium and cosmic rays; much less was said about the alpha emitters. However, there is evidence that many marine organisms accumulate natural alpha emitters to levels that might be contributing substantially to their burden from ionizing radiation. There are increasing opportunities for alpha emitters to enter the ocean because of the increasing use of plutonium-239. Distributions of polonium-210 are of interest because it was found that this natural nuclide accumulates to relatively high levels in some of the same marine ecosystems that accumulate plutonium effectively. The progress of the natural nuclide is technically much easier to follow, yet its distributions might serve to give some warning as to the probable fate of plutonium. Concentrations of polonium-210 in a variety of marine organisms are compared and also the radioactive burdens that may be inferred from bulk tissue samples. Some difficulties of interpretations are discussed and the need for more detailed measurements in specific organs and tissues. Some inferences about polonium-210 from lead-210 measurements also are presented. (auth)

2835 (COO-3482-7) REPAIR OF UV-INDUCED DAMAGE IN MICROCOCCUS RADIODURANS AND A SENSITIVE MUTANT. Howell, P. A. (State Univ. of New York, Buffalo). Sep 1972. Contract AT(11-1)-3482. 88p. Dep. NTIS.

Thesis.

Man

2836 SURVEY ON THE EFFECTS OF RADIOACTIVE DEPOSITS ON THE INHABITANTS OF THE NISHIYAMA DISTRICT IN NAGASAKI PREFECTURE. Okajima, Shunzo (Nagasaki Univ., Japan); Norimura, Toshiyuki; Shiomi, Toshio; Yoshinaga, Haruma; Takeshita, Kenji. Hiroshima Igaku; 24: No. 11, 1106-12(Nov 1971). (In Japanese).

As well as a survey on the amount of residual ^{137}Cs in the bodies of the residents of the Nishiyama district, Nagasaki Prefecture, the results of a survey on the radioactivity present in the soil and farming crops that is thought to cause an increase of the residual ^{137}Cs amount are reported. The clinical examinations of residents in the Nishiyama district, where there was thought to have been fallout from the Nagasaki atomic bombing, revealed no significant findings with the blood test, and showed no abnormality in the thyroid gland. The estimation of the radionuclide body burdens by whole-body counter for residents in the Nishiyama district gave a value for ^{137}Cs that was nearly twice as high as that of any other group. The examination of the chromosomes of the residents of the Nishiyama district revealed a slightly higher percentage of stable type chromosomal abnormality. The ^{137}Cs content in the soil in the Nishiyama district whether it was cultivated or not was high. The ^{137}Cs content in agricultural crops in the Nishiyama district was high particularly in rice, potatoes, and sweet potatoes where it was several times higher than in other groups. (Japan)

2837 METHODS OF RADIATION HYGIENE IN POPULATION PROTECTION. Kunz, E. (Inst. of Hygiene and Epidemiology, Prague). Cesk. Hyg.; 16: No. 4-5, 116-22(Jun 1971). (In Czech).

A review is presented of experience gained, mainly in Great Britain, from the protection of population against the effect of radionuclides released into the environment as a result of nuclear power plant operation. The so-called critical groups concept is dealt with in greater detail. (NSA of Czech.)

2838 MONITORING FOR INTERNAL CONTAMINATION OF CYCLOTRON WORKERS EXPOSED TO TRITIUM. Sakamoto, I. (Inst. of Physical and Chemical Research, Wako, Japan). Rikagaku Kenkyusho Hokoku; 48: No. 3, 76-9(May 1972). (In Japanese).

Tritium gas of 700 Ci was circulated through the ion source of the IPCR 160 cm cyclotron during triton acceleration. After shutdown of the machine, an appreciable amount of tritium was adsorbed by and then released from the inner wall of the cyclotron, and tritium intake occurred in cyclotron workers who were engaged in machine overhaul. Body burden of tritium was calculated according to the equation given in ICRP Publication 10 from the tritium concentration in urine measured by a liquid scintillation counter. The values of total tritium intake for each worker during 6 months following the machine shutdown were 3230 μCi at maximum and 423 μCi on the average. In the period of last 6 months, they decreased to 137 and 44 μCi, respectively, as a result of forced ventilation of the acceleration chamber just before overhauling which kept air contamination in the breathing zone of workers below the maximum permissible level. The effective half-life of tritium in the human body was found to be about 9 days. (auth)

2839 DAY-TO-DAY VARIATION OF URINE ^{90}Sr AS DETERMINED FROM URINE CALCIUM. A CAUSE OF ERROR IN THE ESTIMATION OF BODY ^{90}Sr BY URINALYSIS. Fujita, M.; Iwamoto, J.; Yabe, A.; Akaishi, J. (Japan Atomic Energy Research Inst., Tokai). Hoken Butsuri; 6: No. 4, 171-5(Dec 1971). (In Japanese).

Day-to-day variation of urine ^{90}Sr may produce error in the assessment of body ^{90}Sr by urinalysis. Based on the good correlation between urine ^{90}Sr and Ca, the range of the day-to-day variation of urine ^{90}Sr was inferred from that of calcium, which was obtained from the analysis of about 50 to 100 urine samples per person in seven volunteers. From the frequency distribution curves of urine calcium, it was concluded that 90% of the daily urine ^{90}Sr would be involved in the range from 0.4 to 2.0 times the mean value. Therefore, if the assessment of body ^{90}Sr is made from only one urinary excretion level, the estimated body burden will probably be in the range between 0.4 and 2 times the correct value. (auth)

Animals

Refer also to abstracts 2542 and 2764.

2840 (AEC-tr-7362, pp 170-80) BEHAVIOR AND NATURE OF THE MICRODISTRIBUTION OF ^{239}Pu IN THE RAT ORGANISM AFTER CHRONIC INHALATION OF ITS SOLUBLE COMPOUNDS. Lyubchanskii, E. R. (Inst. of Biophysics, Moscow). Translated from Radiobiologiya; 12: No. 2, 272-8(1972).

The behavior and microdistribution of ^{239}Pu in the organs during and after the end of 160-day inhalation of Pu citrate and ammonium plutonium pentacarbonate were studied in experiments on 205 rats. Good correlation was established between the actual and calculated accumulations of the isotope in the lungs and skeleton during the process of inhalation. A nonuniform distribution of plutonium in the lungs was revealed by the method of histoautoradiography. (tr-auth)

2841 (CEA-CONF-2069) DTPA THERAPY IN THE MONKEY OF LUNG INTERNAL EXPOSURES TO LANTHANUM: EFFECT OF THERAPEUTIC DELAYS AND ROUTES OF ADMINISTRATION ON TREATMENT EFFECTIVENESS. Ducousso, R.; de Regnaud, M.; Perrault, G.; Pasquier, C. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [nd]. 6p. (CONF-720503-7). Dep. NTIS (U. S. Sales Only).

From 2nd European congress on radiation protection; Budapest, Hungary (3 May 1972).

Macacus monkeys were delivered constant lung burdens of $^{140}LaCl_3$ and treated by DTPA administered as aerosol, intravenously, or by slow perfusion at times ranging from 0 to 24 hr following contamination. Therapy was all the more effective as the delay was shorter, and aerosol was the most effective route. (auth)

2842 (CEA-CONF-2070) EXPERIMENTAL RESEARCH ON THE TREATMENT OF CONTAMINATIONS BY ACTINIDE SOLUTIONS. Morin, M.; Skupinski, W.; Nenot, J. C.; Lafuma, J. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 1972. 5p. (CONF-720503-6). Dep. NTIS (U. S. Sales Only).

From 2nd European congress on radiation protection; Budapest, Hungary (3 May 1972).

DTPA therapy must be initiated only if chelation of the isotope is possible. DTPA proved to be effective mostly on the removal of elements of valence III (Am, Cm, Cf). DTPA was quite as effective on ^{238}Pu, but its effectiveness on ^{239}Pu was more difficult to appreciate because of the much slower migration of this isotope. DTPA therapy proved to be ineffective on U, Pa, and Np contaminations. Its renal toxicity makes DTPA especially dangerous in the treatment of U intoxication. (auth)

2843 (LF-tr-73) EVALUATION OF THE MIGRATION IN VITRO OF THE ALVEOLAR HISTIOCYTES: COMPARISON OF THE EFFECT OF ANTISERA AND OF PLUTONIUM OXIDE INTOXICATION. Nolibe, Daniel. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Compt. Rend., Ser. D; 274: No. 1, 77-80(1972). 7p. Dep. NTIS.

An abstract was prepared from the publication in the original language and appeared in NSA Vol. 26 as number 33786. (C.H.)

2844 (UCSD-34-P-71-12) PRELIMINARY DRAFT OF THE ANNUAL REPORT OF PROGRESS FOR THE PERIOD SEPTEMBER 1, 1971-AUGUST 31, 1972. Folsom, T. R. (Scripps Institution of Oceanography, La Jolla, Calif. Soledad Lab.). [nd]. Contract AT(04-3)-34. 9p. Dep. NTIS.

Progress is reported on studies on the use of fallout radioactive tags for exploring movements of the eastern part of the north Pacific Ocean; monitoring of marine organisms for fallout radionuclides to determine rate of change in relation to global fallout rates; concentration of ^{108m}Ag, ^{110m}Ag, ^{137}Cs, ^{60}Co, ^{239}Pu, and ^{65}Zn in albacore (tuna); rate of decrease of fallout ^{137}Cs in muscles and liver of albacore; development of alpha spectrometers; survey of plutonium and polonium in species of algae; concentration of ^{110m}Ag, ^{58}Co, and ^{60}Co in algae, crustaceans, and molluscs; analysis of polonium concentrations on glass and metal plates exposed at Scripps Pier. An outline is presented of studies carried out in collaboration with the National Science Foundation IDOE baseline environmental studies program. (H.L.W.)

2845 DISTRIBUTION, DOSE, AND EFFECT OF ^{90}Sr-^{90}Y IN THE MALE MOUSE FOLLOWING INTRAPERITONEAL INJECTION OF EQUILIBRIUM MIXTURES. Parker, Edward Joseph Jr. Ithaca, N. Y.; Cornell Univ. (1972). 154p. University Microfilms Order No. 72-23,883.

Thesis.

A study of the distribution of ^{90}Sr and ^{90}Y in male BLU: Ha (ICR) mice as related to the dose from both radionuclides was undertaken to determine the effects of a single intraperitoneal injection upon reproduction. Injected doses of equilibrium mixtures ranging in activity from 10.4 μCi to 56.2 μCi were employed. (Diss. Abstr. Int., B)

Plants

Refer also to abstract 2851.

2846 EFFECT OF CITRUS ROOTSTOCK AND CHELATING AGENT ON SPECIFIC ACTIVITIES OF IRON AND ZINC IN SHOOTS OF GRAFTED PLANTS FOLLOWING ^{59}Fe AND ^{65}Zn APPLICATION TO SOIL. Wallace, A. (Univ. of California, Los Angeles). pp 531-7 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

Valencia orange scions were grafted to rough lemon or trifoliate orange rootstocks, and grown with and without chelating agents in calcareous Hacienda loam soil to which high specific activity ^{59}Fe and ^{65}Zn were mixed. Mineral analyses were determined after 85 days in leaves and stems of suckers growing from the rootstocks, and also in new and old leaves and stems of the scions after 119 days. The chelating agents had little effect on iron contents of the plants, but they increased considerably the specific activities of the iron in the shoots. RA 157 increased them more than DTPA and the effects were much more pronounced with rough lemon rootstock than with trifoliate orange. It did not consistently increase zinc content, but DTPA did. DTPA increased specific activities of the zinc, but RA 157 did not. Specific activities of both iron and zinc were higher for rough lemon than for trifoliate orange. (auth)

2847 BEHAVIOUR OF RUTHENIUM IN AN ESTABLISHED PASTURE SOIL AND ITS UPTAKE BY GRASSES. Kirchmann, R.; D'Souza, T. J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). pp 587-93 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

Experiments of voluntary contamination of established pasture by $^{106}Ru^{13}C$ were performed to obtain data: (a) On the field loss of herbage after a direct deposition; (b) on the transfer from the mat to the aerial part of the grass (indirect contamination) and the subsequent transfer from grass to milk; (c) on the distribution of ^{106}Ru in the soil profile and the partition between soil components (water, organic, and mineral fractions). The main results are respectively: (a) The retention, after direct deposition, on herbage, is about 9.5% of the amount deposited; the field loss has a half-life of 8 days (on a dry-matter basis); levels of ^{106}Ru in the second cutting are increasing but fall sharply in the third cutting; (b) the transfer coefficient of ^{106}Ru, from mat to the leaves of the cutting, is 0.45% of the amount deposited per m^2; for the second cutting, the value falls to 1.6×10^{-3}%; the level of ^{106}Ru in milk produced by cows eating contaminated grass (2.2 μCi ^{106}Ru/kg dry matter) is less than 16 pCi/litre; comparisons with values for ^{85}Sr and ^{134}Cs obtained previously in similar natural conditions are made; (c) in the solution collected, over about one year, from Ebermayer lysimeters, the concentrations vary slowly; the activity of the water fraction extracted from the soil is in good agreement with the lysimeter results; the organic and fine-material fractions are responsible for the very high degree of fixation observed, and in the coarse mineral fraction (mainly sand) the fixation is low (K_d value about 7.5). The results are discussed. (auth)

2848 DISTRIBUTION OF RADIOSTRONTIUM AND RADIOCESIUM IN THE ORGANIC AND MINERAL FRACTIONS OF PASTURE SOILS AND THEIR SUBSEQUENT TRANSFER TO GRASSES. D'Souza, T. J.; Kirchmann, R.; Lehr, J. J. (CEEN, Mol, Belg.). pp 595-604 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

Pasture soils from four different locations in Belgium, artificially contaminated with radiostrontium and radiocesium, were studied over a period of two years with respect to the distribution of the radionuclides in the plants, soil organic matter (mat), and soil mineral matter (sol) both under field and greenhouse conditions. The observed ratios OR = (Sr/Ca) plant/(Sr/Ca) mat, (Sr/Ca) plant/(Sr/Ca) sol, (Sr/Ca) mat/(Sr/Ca) sol for radiostrontium, and concentration ratios CR = (Cs/g dry wt plant)/Cs/g dry wt mat), (Cs/g dry wt plant)/(Cs/g dry wt sol), (Cs/g dry wt mat)/(Cs/g dry wt sol) for radiocesium were worked out and these were compared with the type of the soil and the time of cropping. The results indicated: an exponential relation between the clay content of the soils and the OR mat-sol for radiostrontium; a great movement of radiostrontium from sol to mat in soils of low clay and high organic matter content; an equilibrium of radiostrontium present in the sol and mat in soils of medium clay and low organic matter content; movement of radio-

cesium from sol to mat that was reversed after two pasture croppings; greater transfer of cesium to the grass after the third growing season, in soils of low clay content; and with the exception of soils of low clay content, the CR values were higher for recent deposition than for older deposition of radiocesium. (auth)

2849 RETENTION OF SIMULATED FALLOUT PARTICLES BY LICHENS AND MOSSES. Taylor, F. G.; Witherspoon, J. P. (Oak Ridge National Lab., Tenn.). Health Phys.; 23: No. 6, 867-9(Dec 1972).

A study was made to determine the initial interception and retention of fallout particles by tussock forming lichens and mosses. A fallout simulant (88 to 175 μ diameter) containing ^{134}Cs was used to show that for these lower plants (cryptogams) weathering half-times are somewhat longer but within a factor of two of those obtained for similar components of higher plants. These results could be due to the lodgement of particles in the lichen-soil interface and moss-litter zones. (UK)

New Tracer Techniques

Refer also to abstract 2671.

2850 (COO-3013-40) KINETICS OF CELLULAR PROLIFERATION IN NORMAL AND MALIGNANT TISSUES. NORMAL TISSUES AND MALIGNANT TUMORS OF THE UPPER AIR PASSAGE. Fabrikant, J. I. (Connecticut Univ., Farmington. Dept. of Radiology). [nd]. Contract AT(30-1)-4244. 91p. (CONF-711036-3). Dep. NTIS.

From Conference on the biological and clinical basis of tumor radiosensitivity; Rome, Italy (7 Oct 1971).

A review is presented of studies on regulation of cell reproduction in renewal tissues and cell population kinetics in normal and neoplastic tissues. Tritium-labeled uridine, leucine, and thymidine were used as tracers for in vitro tissue samples. Discussions are presented under the following headings: cell population kinetics; cell cycle; analysis of cell population kinetics; tissue doubling time; cell loss in tumors; studies on normal and malignant tissues; cell labeling as a function of zone of incorporation; cell labeling as a function of time; clinical studies on patients with diseases of the upper respiratory tract; sites of cellular proliferation; rates of cellular proliferation in epithelial tissues of the upper respiratory passages; duration of DNA synthesis in human tissues; proliferation rates in primary and metastatic neoplasms; and RNA synthesis in proliferating tissues. (H.L.W.)

2851 (STI/PUB-292) ISOTOPES AND RADIATION IN SOIL-PLANT RELATIONSHIPS INCLUDING FORESTRY. Proceedings Series. Proceedings of the Symposium Held in Vienna, 13-17 December 1971. (International Atomic Energy Agency, Vienna (Austria)). Jun 1972. 684p. (In several languages). (CONF-711213). IAEA $21.00.

Separate abstracts were prepared for 15 of the 54 papers presented in the symposium. The other 39 papers discuss the following general topics: ion uptake and translocation; soil chemistry and analytical methods; tree physiology; ecology and mineral cycling in forests; soils and the water regime in forests; and soil fertility and nutrient availability. (E.R.B.)

For abstracts of individual papers see: 2313, 2444, 2605, 2631, 2739, 2846-2848, and 2852-2858.

2852 CHARACTERIZATION OF NUTRIENT SUPPLY MECHANISMS TO PLANT ROOTS USING DOUBLE LABELLING AND THE RATIO OF Ca:Sr ABSORBED. Barber, S. A.; Elgawhary, S. M.; Malzer, G. L. (Purdue Univ., Lafayette, Ind.). pp 11-20 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

The non-discriminatory uptake of Ca and Sr by tomato (Lycopersicon esculentum) roots was used to determine the mechanisms supplying Ca and Sr to the root. Soil Ca was labeled with ^{45}Ca and soil Sr with ^{85}Sr. Because of differential strengths of binding of Ca and Sr by the soil, the Ca:Sr ratio of the soil solution cations differed from the Ca:Sr ratio of the exchangeable cations. Some exchange materials adsorbed Ca preferentially to Sr, whereas others adsorbed Sr preferentially to Ca. Tomatoes were grown on two different exchange materials for six growth periods. Uptake rate and rate of supply by mass-flow and by diffusion were measured per cm of root for each time period for both Ca and Sr. When mass-flow supplied Ca and Sr to the root at a rate faster than uptake, the Ca:Sr ratio of the cations absorbed by the plant was similar to the Ca:Sr ratio found in the equilibrium soil solution. When the rate of transpiration was reduced by growing the plants under high humidity, mass-flow supplied only part of the amount absorbed and diffusion of Ca and Sr to the root was important. Under these conditions the ratio of Ca and Sr absorbed was similar to the ratio of Ca:Sr on the exchange sites. This indicated that the diffusion of Ca and Sr to the root was by exchange diffusion rather than by solution diffusion. When the supply by mass-flow greatly exceeded uptake, Ca and Sr accumulated near the root surface. This accumulation can become great enough to cause precipitation about the root. Since the Sr level was only one two-hundredth the Ca level and also because the solubilities of the Ca and Sr salts differ, there may be differential precipitation of Ca and Sr. This differential precipitation may result in a change in the Ca:Sr ratio of these ions in solution at the root. (auth)

2853 COMPARISON OF THE USE OF ^{86}Rb AND ^{42}K AS RADIOACTIVE TRACERS IN THE STUDY OF POTASSIUM ABSORPTION BY SORGHUM. Morard, P.; Bur, R. (Ecole Nationale Superieure Agronomique, Toulouse). pp 59-66 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972). (In French).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

As there are no potassium radioisotopes convenient to use (half-life too short or too long), many authors have agreed that ^{86}Rb can be an appropriate tracer of K. In order to test this hypothesis, the authors conducted two absolutely identical experiments using ^{86}Rb or ^{42}K as tracers. The radioisotopes are introduced into the nutrient solution and brought into contact for one, six, nine, and twenty-four hours with part or the whole of the sorghum root system at the seven-leaf stage. The results demonstrate differences in the behavior of the two tracers, both as regards their total absorption and their distribution within the plant. In the case studied, ^{86}Rb is not a satisfactory tracer of potassium for studying the absorption and distribution of the element in whole plants. (auth)

2854 USE OF NUCLEAR TECHNIQUES IN SOIL, AGROCHEMICAL, AND RECLAMATION STUDIES. Rachinskii, V. V. (Agriculture Academy, Moscow). pp 123-30 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972). (In Russian).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

A survey is given of studies on the use of the radioisotopes ^{14}C, ^{32}P, and ^{35}S in research on the dynamics of soil sorption processes, transformation of organic substances, water transport, and the dynamics of the leaching of salts in soil. (auth)

2855 USE OF ISOTOPES FOR IONIC TRANSPORT STUDIES IN SOIL. Cho, C. M. (Univ. of Manitoba, Winnipeg). pp 145-52 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

Isotopic exchange reactions between labeled inorganic ions and the corresponding isotope in the solid phase of the soil matrix modifies the transport of the labeled ion from that of the natural isotope. The degree of modification is a function of the rate constant as well as the quantities in the respective phases. Experimental results of ^{32}P movement in several soils indicated that it always traveled more slowly than ^{31}P. However, if the local concentration of ^{31}P was very high and shaped like a normal distribution curve, then the movements of ^{31}P and ^{32}P were very similar. A theoretical analysis of this behavior was carried out applying the dispersion and diffusion equations of P transport. The results indicated that the velocity of the center of mass and the diffusion coefficient of P measured by the ^{32}P in soil were all functions of the isotopically exchangeable phosphate in soil as well as the rate of P application. (auth)

2856 USE OF TRITIATED WATER FOR DETERMINATION OF PLANT TRANSPIRATION AND BIOMASS UNDER FIELD CONDITIONS. Kline, J. R.; Stewart, M. L.; Jordan, C. F.; Kovac, Patricia (Argonne National Lab., Ill.). pp 419-

37 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

The use of tritiated water for measurement of transpiration in forests, biomass of trees, and transpiration in grasslands is discussed. The methods are based on a previously published theory of tracer dynamics in steady state systems. During the summer of 1971, a plantation of jack pine (Pinus banksiana) utilized water at rates ranging from 4.9 mm/d in early June to 1.6 mm/d during late August when soil moisture deficit was severe. During a five-week period of intensive measurement, rainfall plus soil moisture depletion totaled 14.9 cm of water. Forest transpiration for the same period was estimated by the tritium method to be 14.7 cm. The theory of tracer dynamics that permits transpiration measurements also has implications for determining other plant quantities. Among these is the measurement of system pool size that in plants is simply the total water content. Biomass of a tree is computed from pool size as measured by tracer methods and the moisture percentage of the plant. Dry biomass of a red pine (Pinus resinosa) forest was estimated to be 7.7×10^4 kg/ha by the proposed tracer method, and 7.3×10^4 kg/ha by the harvest method. Biomass in excess of 400 kg dry weight per tree was measured. In grasslands where pool size can be measured by direct harvest, it is possible to measure transpiration rate on an area basis using the same theory. Results for simulated grasslands indicate that the transpiration rate for five trials with the tritium method had an average deviation of 7.4% from rates determined by weight loss. It is concluded that tritiated water is a reliable tool for the determination of transpiration and biomass in forests and grasslands. (auth)

2857 STUDIES ON THE PATTERN OF ROOT ACTIVITY OF TREE CROPS USING ISOTOPE TECHNIQUES. Broeshart, H. (International Atomic Energy Agency, Vienna); Nethsinghe, D. A. pp 453-63 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

The study of root activity distribution patterns by means of isotope techniques often involves the injection of solutions containing a tracer (usually ^{32}P) into the soil and subsequent determination of the tracer level in a leaf sample. In general it is possible to determine where the most active part of a root system is located with respect to the base of the tree, but it is not possible to make a quantitative comparison of root activity of leaf samples taken from leaves of similar age and well-defined morphological position from trees subjected to soil injections at various distances and depths frequently shows a high error. This means that only very large differences in root activity can be significantly detected. A comparison between ^{32}P and ^{15}N is lower than for ^{32}P. An experiment was carried out with Betula and Fraxinus trees using a double-labeling technique with ^{32}P and ^{33}P. ^{33}P was applied in a standard position with respect to the tree and ^{32}P at a location and rate corresponding with the treatment. The expression of treatment effects in terms of a ratio of the standard to the variable treatment was shown to reflect quantitatively the rate of soil injection. The variability of the ratios was much lower than that of single activity counts. The double-labeling method does not require the selection of samples of a particular age or morphological position, and soil injection need not be restricted to rings around trees. (auth)

2858 SIMULTANEOUS DETERMINATION OF THE VALUES A AND L OF PHOSPHORUS IN A SOIL BY MEANS OF ^{32}P AND ^{33}P. Fardeau, J. C.; Jappe, Jocelyne (CEN, Cadarache, France). pp 499-506 of Isotopes and Radiation in Soil-Plant Relationships Including Forestry. Vienna; International Atomic Energy Agency (1972). (In French).

From Symposium on the use of isotopes and radiation in research on soil-plant relationships including applications in forestry; Vienna, Austria (13 Dec 1971). See STI/PUB-292; CONF-711213.

^{33}P was used simultaneously in a pot experiment on ryegrass to determine isotopically exchangeable soil phosphorus and a granulated fertilizer (ammonium polyphosphate) labeled with ^{32}P. This double labeling makes it possible to measure, in the same sample, the size of pool L and the soil value A in the presence of the fertilizer. The results obtained yield an explanation of this value A, which is in fact the product of the quantity L and a coefficient K characteristic of the fertilizer used in the experiment. In the light of this result an experimental schedule is described for determining the utilization coefficient of fertilizers based only on labeling of the exchangable soil phosphorus and making use of a comparison of the specific activities of plants grown with and without fertilizers. The proposed method has the merit, among others, of being directly applicable to fertilizers in their commercial form. It is no longer necessary to synthesize them in the laboratory or to irradiate them in a reactor. In the same experiment, the method was applied to nitrogen by using ^{15}N to ascertain the assimilation by ryegrass of the ammonium deriving from polyphosphate. Finally, an application is described to measure the degree of assimilation by calcareous soil of manganese and zinc contained in Thomas slag. (auth)

2859 ^{85}Sr SCINTIMETRY IN ANKYLOSING SPONDYLITIS. Ranawat, N. S.; Rivelis, M. (New York Hospital, N. Y.). J. Amer. Med. Ass.; 222: No. 5, 553-8(30 Oct 1972).

Strontium-85 step-scan scintimetry of the sacroiliac joints and spine was performed in 19 patients with established or suspected ankylosing spondylitis two weeks after intravenous injection of 100 μCi of strontium nitrate-^{85}Sr. In completely ankylosed sacroiliac joints and spine, scintimetry values were normal, indicating the disease was clinically arrested. Localized high uptake was observed in several patients, corresponding with areas of complaint. Tomograms of these areas demonstrated destructive changes of vertebral bodies. Uptake of ^{85}Sr was high in cases with early roentgenographic changes of the sacroiliac joints and minimal spinal involvement. Observations were similar in two patients in whom ankylosing spondylitis was suspected clinically. This indicated new bone formation, suggesting activity of the disease not yet seen on roentgenograms. The method is potentially valuable for establishing early diagnosis when used in conjunction with conventional clinical and radiologic techniques. (auth)

2860 IMPAIRMENT OF THE LUNG CLEARANCE MECHANISM BY RESPIRATORY INFECTION. Creasia, D. A.; Nettesheim, P.; Hammons, A. S. (Oak Ridge National Lab., Tenn.). Health Phys.; 23: No. 6, 865-7(Dec 1972).

The effect of influenza virus infection on the clearance of dust particles from the respiratory tract of mice has been investigated using $^{51}Cr_2O_3$ as a tracer. Ten μg of $^{51}Cr_2O_3$ were administered by intratracheal injection, 7 days after intranasal inoculation of PR 8 influenza virus. Data on the dust clearance of 7 infected mice and 40 uninfected controls is given. For the 5 most heavily affected animals the time required to eliminate 50% of the particulates initially deposited was more than 84 days as compared to 12 days for the uninfected controls. It is suggested that studies of clearance kinetics without rigid control of respiratory disease may give erroneous results. Also individuals succumbing to respiratory infections may accumulate markedly higher levels of particulates than nondiseased individuals which could have serious effects in the case of inhalation of radioactive particulates. (UK)

MATERIALS

Ceramics and Cermets

Refer also to abstracts 2919, 4340–4343, 4348, 4356, 4717–4720, 4722, and 4775.

2861 (AD–740941) HIGH-TEMPERATURE OXIDATION OF METALS, ALLOYS, AND CERAMIC CARBIDES AND BORIDES. Final Report, July 1966–September 1971. Graham, H. C. (Aerospace Research Labs., Wright-Patterson AFB, Ohio). Jan 1972. 11p. (ARL–72-16). NTIS.

A knowledge of high-temperature oxidation mechanisms is fundamental to the design or improvement of vehicle materials which resist extreme oxidizing environments. The oxidation behavior of several Ni-base alloys was studied to 1200°C. ZrB_2 and ZrB_2–SiC oxidation was studied to 2000°C. Of particular importance in these studies was the determination of the oxidation reaction kinetics by continuous weight change measurements as a function of temperature and oxygen partial pressure. The major accomplishments of the research effort are summarized and the publications generated under this program are listed. (auth) (GRA)

2862 (AECL–4144) METAL FIBER REINFORCED CERAMICS. Simpson, L. A.; Wasylyshny, A. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Oct 1972. 28p. Dep. NTIS (U. S. Sales Only). AECL $1.00.

Several metal-fiber-reinforced ceramic composites were fabricated by hot pressing. The effect of molybdenum fibers on the fracture toughness of an alumina matrix composite was studied in some detail. Ten volume percent of fibers was found to increase the fracture toughness about two hundred times over that for pure alumina. Nb–Al_2O_3, Ti–Al_2O_3, Zr–Al_2O_3 and Mo–$MgAl_2O_4$ composites were also examined, but none had mechanical properties approaching those of molybdenum–alumina composites. Several other fabrication techniques were examined, namely cold pressing and sintering, slip casting, and plasma spraying, but they all yielded products inferior to those obtained by hot pressing. (auth)

2863 (BNWL-SA–4404) VACUUM DEGASSING OF NUCLEAR FUEL. Brite, D. W. (Battelle Pacific Northwest Labs., Richland, Wash.). 1 Sep 1972. Contract AT(45-1)-1830. 7p. (CONF-720945–1). Dep. NTIS.

From Annual symposium of Pacific Northwest section, American Vacuum Society; Vancouver, B. C. (8 Sep 1972).

It is noted that volatile impurities found in UO_2 include adsorbed gases such as N, CO_2, CO, H_2O, and H. Vacuum outgassing of oxide fuels is done by placing the fuel in stainless steel trays or containers and heating at pressures of 25 microns or less. The primary reason for excluding impurities is the susceptibility of Zircaloy cladding to reaction with hydrogen-containing compounds to form ZrH. (J.R.D.)

2864 (EURFNR–1006) POST-IRRADIATION STUDIES WITH THE MICROPROBE ON UO_2 AND $(U,Pu)O_2$ FUEL RODS IN TEST GROUPS 3 AND 4a OF THE FR-2 CAPSULE IRRADIATIONS. Huber, H.; Kleykamp, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Feb 1972. 90p. (KFK–1324). Dep. NTIS.

For United States–EURATOM Fast Reactor Exchange Program.

Post-irradiation studies with the shielded microprobe analyzer were performed on UO_2 and $(U_{0.85}Pu_{0.15})O_2$ fuel elements of the number 3 and 4a test series of the FR2 capsule irradiations. The studies involved with the thermal neutron irradiated specimens up to about 6.5% burnup were radial distribution of U and Pu, distribution of fission products in the fuel and at the cladding, and compatibility of the fuel with the cladding. A decrease of the U concentration was observed in the outer region of the UO_2 fuel (11.5% ^{235}U) based on the flux depression and the corresponding decrease of fission density in the inner region. A large increase of the Pu concentration near the central void combined with a flat minimum in the outer region of the columnar grain zone was established in the mixed oxide fuel. Both these effects are primarily based on the thermal diffusion of PuO_2 in the thermal gradient. The behavior of the U concentration is complementary. The composition and distribution of various metallic and oxide fission product inclusions which in part contained the components of the stainless steel cladding material were investigated. In addition to the known metallic inclusions consisting of Mo, Tc, Ru, Rh, and small amounts of Pd, Sn, and Te containing phases and Fe rich precipitations together with Pd, Ni, Mo, and Tc were observed. On the other hand several oxide phases containing Cs, Sr, Ba, Zr, Mo, and probably Cr were found. No incompatibilities were established at the fuel-cladding interface of the UO_2 fuels. On the contrary, reactions were observed in the mixed oxide specimens with the exception of those with the minimum burnup of 1.3%: cladding material was transported into the fuel up to about 1.2 mm, most extensively Fe, in smaller amounts Ni. Furthermore an intergranular and layerwise attack of the cladding with reaction zones up to 0.2 mm were established. Cr was enriched on grain boundaries or at the surface of the cladding the behavior of Ni and especially of Fe was complementary. Moreover enrichments of Cs, Ba, Mo, and Te at the fuel cladding interface were detected. (auth)

2865 (GERHTR–4) COATING OF NUCLEAR FUEL PARTICLES BY PROPENE PYROLYSIS IN 1" AND 3" FLUIDIZED BEDS. Gyarmati, E.; Nickel, H. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). Translation of report JUL–686-RW. 41p. Dep. NTIS.

Work performed under United States–German High Temperature Reactor Research Exchange Program.

Results of studies on pyrolytic carbon deposition from propene (C_3H_6) and methane (CH_4) are reported. It was found that pyrolytic carbon with different structure such as columnar, granular, dense-isotropic, sooty-isotropic, and porous can be deposited on fuel particles in 1- and 3-inch fluidized beds dependent on the propene concentration and the deposition temperature. Methane decomposition leads to laminar, granular, isotropic, and columnar pyrolytic carbons with the structure depending on the CH_4-concentration and temperature. Fuel particles with isotropic high-density pyrocarbon show the best irradiation behavior. Pyrolysis of propene within a temperature range between 1250 and 1350°C results in a high density isotropic layer which is comparable to layers produced with methane above 1800°C. The density of the PyC deposited by pyrolysis of C_3H_6 reaches a minimum at a deposition temperature of 1500°C and increases with further increase in temperature. This behavior does not depend on the bed geometry. When the PyC is deposited from CH_4 there is also a minimum in density at 1500°C. The anisotropic orientation of PyC microcrystallites depends on hydrocarbon concentration, deposition temperature, and bed geometry. The value of the Bacon Anisotropic Factor (BAF) for the pyrocarbon deposited above 1500°C from methane is ≤ 1.1, a function of the CH_4 concentration. This low BAF value can already be achieved with the propene pyrolysis at 1250°C with an appropriate C_3H_6 concentration. PyC with high density and isotropic structure from propene is deposited on fuel particles between 1250 and 1350°C. The apparent crystallite size (L_c) of this PyC ranges between 20 and 60 Å depending on the C_3H_6 concentration and the bed geometry. PyC, produced by CH_4 pyrolysis which shows comparable density and structure can only be deposited between 1800 and 2100°C. The L_c values then vary between 70 and 140 Å. The efficiency in pyrocarbon depends for both gases on decomposition temperature and concentration. This efficiency lies for propene in the interesting temperature range (1250 to 1350°C) between 45 and 60% and for methane (1800 to 2100°C) above 70%. With propene higher deposition rates for dense-isotropic PyC are achieved than with methane. For this reason, propene used as pyrolysis gas gives an economical advantage. In consequence of the low deposition temperature for the production of isotropic, high density pyrocarbon by the pyrolysis of propene, the layers of the coated particles show a lower heavy metal contamination than the pyrocarbon layers obtained by methane pyrolysis. (auth)

2866 (HEDL-TME–72-102) MICROSTRUCTURE CHARACTERISTICS OF PNL-9, 10, AND 11 IRRADIATION TEST FUELS. Carlson, M. C. J. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1972. Contract AT(45-1)-2170. 38p. Dep. NTIS.

Quantitative porosity characterization, grain structure characterization and composition distribution evaluation for fuel batches used in EBR-II irradiation test subassemblies PNL-9, 10, and 11 are shown. The homogeneity Figures of Merit for PNL-9, 10, and 11 fuels were all calculated to be greater than 0.99 as compared to 1.00 for a completely homogeneous material, indicating a high degree of homogeneity for the fuel in these subassemblies when evaluated on the basis of fission product energy deposit. Analysis showed stainless steel and tungsten rich inclusions. (auth)

2867 (HIT–527) Ni/ZrO_2 HIGH TEMPERATURE THERMAL SWITCH PROGRAM. Final Report, July–December 1971. (Hittman Associates, Inc., Columbia, Md.). Jul 1972. Contract AT-(29-2)-2797. 36p. Dep. NTIS.

A high temperature metal thermal switch program is described which is directed to the design, development, and testing of thermal switch composite materials for reentry protection of radioisotope thermoelectric generator (RTG) heat sources. In the previous phase of the program, the development of a nickel/zirconia composite prepared by an electroless nickel deposition technique was reported. The nickel deposited was a high purity, boron- and phosphorus-free, nickel with a melting temperature close to that of pure nickel. Current activities are directed toward further development of the electroless nickel deposition-impregnation process for the fabrication nickel/zirconia composite sleeves with a uniform nickel impregnation throughout the sleeve. A process specification was prepared for the fabrication of nickel/zirconia composite sleeves. Thermal conductivity data on nickel/zirconia composites was determined by the cut-bar comparative test. The conductivity at 500°F was determined for four nickel loadings of 1.6, 1.8, 2.0, and 2.3 grams Ni/cc and conductivities of 1.8, 2.0, 2.5, and 3.3 Btu/hr · ft · °F were measured. The thermal conductivity measurements show good agreement with data reported in the previous phase. Mechanical property measurements show increased compressive and transverse rupture strengths over composites fabricated and tested in the previous phase. These improvements are attributed to improved impregnation processing and uniform dispersion of nickel throughout the composites. Compatibility testing of zirconia coated Ni/ZrO_2 composites against Pt-20Rh, T-111, tantalum alloy and graphite at 1500°F in argon showed no reaction after 5100 hours at 1500°F. Sublimation of nickel from zirconia coated and uncoated Ni/ZrO_2 composites was evaluated at 1800°F under one atmosphere argon for 5000 hours. The nickel sublimation from the coated and uncoated composite specimens was very low and no significant difference in sublimation was found between the coated and uncoated specimens. A thermal switch-centrifuge test was performed to determine the effect of the centrifugal forces on the ability of the composite to "switch" when the composite is heated to the "switching" temperature. The test showed that the centrifugal forces had little or no effect on the ability of the composite to completely "switch." (auth)

2868 (KFK–1649) THERMODYNAMIC INVESTIGATION OF THE SOLUBILITY OF OXYGEN IN TERNARY METAL URANIUM OXIDE WITH A SOLID STATE GALVANIC CELL. Stadlbauer, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Jul 1972. 71p. (In German). Dep. NTIS (U. S. Sales Only).

In the selected regions La: (La + U) = 0.05 and O: (La + U) = 2.00 of the ternary system lanthanum–uranium–oxygen emf measurements on solid state galvanic cells, coulometric titrations, and x-ray diffraction techniques were used to obtain phase boundaries and thermodynamic data in the temperature range from 600 to 1000°C. On the basis of the experimental molar solution-entropy of oxygen, a statistical method is given for estimating the fluorite phase of nonstoichiometric metal–uranium–oxygen–systems and the molar vibration-entropy of oxygen in the crystal lattice. (auth)

2869 (SC-T–722552) ELECTRON SPECTRUM AND PHYSICAL PROPERTIES OF DODECABORIDES. Goryachev, Yu. M.; Odintsov, V. V.; Paderno, Yu. B. Translated by Patricia Newman (Sandia Labs., Albuquerque, N. Mex.), from Metallofizika; No. 37, 29-36(1971). 12p. Dep. NTIS.

The electric conductivity and thermal emf in a temperature range from room temperature to 900°C, microhardness at room temperature, the coefficient of thermal expansion in the temperature range from –196 to 1000°C, and the Hall coefficient and thermal conductivity at room temperature of dodecaborides of Y, Tb, Dy, Er, Tm, Yb, Lu, and Zr, prepared by reducing metal oxides with boron in a vacuum, were studied. Regular variations in the properties of the dodecaborides were observed. The semimetallic nature of YbB_{12}, probably due to the fact that Yb tends toward a bivalent state, was established experimentally and confirmed by theoretical calculation. The established variation of dodecaboride properties agreed with the results of a calculation of the electron spectrum and the consequences derived from it (quantity of charge and thermodynamic stability). (P.C.H.)

2870 RECENT TREND OF RESEARCH ON CEMENTED CARBIDES. Suzuki, H. (Tokyo Univ.). Nippon Kinzoku Gakkai Kaiho; 11: No. 2, 125-34(Feb 1972). (In Japanese).

The recent trend of research on the mechanical properties of cemented carbides, especially the WC–Co group, is summarized. In the case of WC–Co alloy, Co is added as a binder phase. The relation between the mechanical properties and content of the Co in the alloy was investigated. Binders other than Co were also investigated. A phase diagram of W–C–Co ternary system gave information on the composition of the binder phase. The binder phase sometimes takes the metastable structure of a higher temperature phase. The aging effect was found in the binder phase of several kinds of alloys. The particle size of carbides in the ternary alloy as well as carbon content, had a marked effect on the strength of the alloy, along with contiguity of the carbide particles. Properties of the carbide and concentration of defects and impurities contained in carbide phase also affect the strength. Thermal stresses produced in each phase during cooling process, existence of micro-pores, and testing methods are also discussed. Theories on the strength of cemented carbides are briefly described. (Japan)

2871 THERMODYNAMICS OF THE SYSTEM VO_2–V_2O_5 AND VO_2–V_2O_5–H_2O. Suito, Hideaki. Philadelphia; Univ. of Pennsylvania (1972). 161p. University Microfilms Order No. 72-25,674.

Thesis.

Using a gravimetric technique, the oxygen isobars in the liquid phase field of the system $VO_2-V_2O_5$ have been determined in the temperature range 1020 to 1100°C and in the oxygen pressure range 0.01 to 0.40 atmospheres, and the VO_2 liquidus and solidus curves have been determined in the temperature range 953 to 1081°C. From these results have been calculated the activities of the components VO_2 and $VO_{2.5}$ in the system and the standard free energy change for the reaction $2VO_2(S) + \frac{1}{2}O_2(g) = V_2O_5(l)$. The latter was determined to be $\Delta G^0 = -17{,}780 + 7.64T$ in the temperature range 1020 to 1100°C. The apparent vapor pressures of melts in the system $VO_2-V_2O_5$ and the apparent vapor pressures of vanadium hydroxides formed by reaction of these melts with water vapor have been measured by means of a transpiration technique at 1025, 1055, 1083, and 1099°C in the oxygen pressure range 0.01 to 0.40 atmospheres. By combination of these results with activities of VO_2 and $VO_{2.5}$, the enhanced volatilization in the presence of water vapor (148–456 mm Hg) was found to occur by the reactions $V_2O_5(l) + \frac{1}{2}O_2(g) + 2H_2O(g) = 2VO_2(OH)_2(g)$ and $VO_2(S) + H_2O(g) = VO(OH)_2(g)$. The volatilization reactions over the liquid non-stoichiometric V_2O_5 can be described as $V_2O_5(l) + \frac{1}{2}O_2(g) = 2VO_3(g)$ and $VO_2(S) = VO_2(g)$. (Diss. Abstr. Int., B)

2872 PROCEEDINGS OF THE FOURTH ANNUAL TECHNICAL MEETING, DENVER, COLORADO, SEPTEMBER 21–23, 1971. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972). 340p. (CONF-710902).

A total of 35 papers were presented at the conference. A separate abstract was prepared for each of twelve papers. The remaining 23 papers were not in scope for NSA. (J.R.D.)

For abstracts of individual papers see: 2873–2875, 2911, 2921–2923, 2945–2948, and 2993.

2873 SAMPLE PREPARATION AND EQUIPMENT PROBLEMS ASSOCIATED WITH RE-CYCLED, PURIFIED ATMOSPHERES. Bender, J. S. (Los Alamos Scientific Lab., N. Mex.). pp 27-30 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

Sample preparation for metallography in hot cells equipped with a system to remove water and oxygen from re-cycled argon requires extreme care in the choice of lubricants and cleansing solvents. This care is necessary to prevent chemical reactions with the purification "bed" that produce by-products which attack the plumbing of the system. Etching solutions are also incompatible with purification systems but minimal amounts and quick disposal prevent serious attack. Polishers and grinders equipped with carbon brushes require changing to resin-bonded graphite/molybdenum disulfide brushes and ultrasonic cleaners have shown the need for high quality components in the generator circuitry. (auth)

2874 CATHODIC VACUUM ETCHING OF NUCLEAR CERAMIC FUELS. Goffard, J. W.; New, K. H. (WADCO Corp., Richland, Wash.). Contract AT(45-1)-2170. pp 127-32 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

The revelation of the microstructural features of irradiated nuclear ceramic fuel specimen has been enhanced by the application of inert ion bombardment (argon). This cathodic etching has been successfully performed on some of the world's original, unmodified hot cell equipment. The techniques and procedures

used to accomplish this supplemental etching of the epoxy resin mounted and impregnated nonconducting specimens are described. The surfaces so developed are suitable for optical microscopy, replication and higher resolution electron microscopy, and microprobe analysis. Examples of the developed microstructures and some interpretative results are presented. (auth)

2875 QUANTITATIVE ANALYSIS OF A CERMET SPHERE. Kelly, M. D.; Selle, J. E. (Monsanto Research Corp., Miamisburg, Ohio). pp 213-17 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

A ThO_2-molybdenum cermet sphere was fabricated as part of the development effort relating to the multi-hundred watt heat source program. Molybdenum-coated ThO_2 shards were pressed into a 1½ inch diameter sphere using graphite dies. The graphite was removed by machining leaving the composite sphere. The sphere was sectioned through the poles, metallographically polished, and analyzed using the Leitz Classimat to determine pressing characteristics. Density, form factor, particle size, composition, and orientation measurements were taken. Metallographic procedures, as well as the operation of the Classimat and the interpretation of the composite sphere data, are discussed. (auth)

2876 PREPARING DISPERSION-HARDENED MATERIALS FOR TRANSMISSION ELECTRON MICROSCOPY. Lindbo, J.; Leffers, T. (Danish Atomic Energy Commission, Risoe). Metallography; 5: No. 5, 473-7(Oct 1972).

A method is described that has proved successful in producing very good thin foils from all the dispersion-hardened materials to which it has been applied, namely Al with Al_2O_3, Zr and Zircaloy-2 with Y_2O_3, and high-purity Fe and austenitic stainless steel with Al_2O_3. The method also yields superb thin foils of the matrix materials without dispersoids. (P.C.H.)

2877 INFLUENCE OF STOICHIOMETRY ON COMPRESSION CREEP OF POLYCRYSTALLINE UO_{2+x}. Seltzer, M. S.; Clauer, A. H.; Wilcox, B. A. (Battelle Memorial Inst., Columbus, Ohio). J. Nucl. Mater.; 44: No. 3, 331-6(Sep 1972).

Compressive creep tests have been performed on polycrystalline hyperstoichiometric uranium dioxide, as a function of temperature, stress and deviation from stoichiometry. Under low stresses measured steady-state creep rates for UO_{2+x} increase linearly with applied stress, σ, and with oxygen excess, x. Creep rates for UO_{2+x} tested at high stresses follow a power-law stress dependence of the form $\dot{\epsilon} \propto \sigma^n$ where $4 < n < 7$, and increase with x^m where $1.75 < m < 2$. The transition stress, σ_t, between linear and power-law stress dependence behavior decreases with increasing O/U ratio. For polycrystals tested at high stresses, the creep activation energy, Q_c, decreases with increasing x in the same manner as found for uranium dioxide single crystals. Creep activation energies also decrease with increasing x in the linear stress-dependence region, but values for Q_c are lower at a given x than are values obtained in the power-law stress region. It is suggested that different diffusion processes control the observed creep behavior in the two different stress regimes. (auth)

2878 PROGRESS OF FIBRE REINFORCED METAL MATRIX COMPOSITES. Hanby, K. R. Light Metal Age; 29: No. 9-10, 8; 10-11(1971).

Research development involving Al/B composites, composites with Ti matrices and other metal/matrix composites during 1969–1970 include: the first flight test of a metal/matrix composite aircraft structural element, an engine access door of Al/B; a study of the feasibility of using Al/B, epoxy/B or epoxy/C composites in large space launch vehicles; continuous casting as a means of preparing Al/B composites; a modification of the plasma-sprayed-tape process of composite fabrication used to prepare 6061 Al alloy composites with Borsic filaments; a study of explosive bonding as a consolidation process for ductile-wire composites; production of Ti/Be composites by coextrusion; a study of interactions in Ti matrix composites; the development of Ni matrix composites with sapphire filaments; and a study of compatibility in Al/graphite systems. (Metals Abstr.)

2879 COMPRESSIVE CREEP OF MIXED-OXIDE FUEL PELLETS. Routbort, J. L.; Javed, N. A.; Voglewede, J. C. (Argonne National Lab., Ill.). J. Nucl. Mater.; 44: No. 3, 247-59(Sep 1972).

The steady-state compressive creep rates of mechanically mixed UO_2-25 wt% PuO_2 fuel pellets have been measured between 1300 and 1700°C, at stresses of 6.9–110 MN/m² (1–16 ksi) and at oxygen-to-metal ratios of 1.90–2.00. The dependence of the creep rate ($\dot{\epsilon}$) on stress (σ), temperature (T) and grain size (d) for an O/M ratio of 1.97 may be accurately described by the linear superposition of a viscous flow and a power-law creep relation $\dot{\epsilon} = (A/d^2)\sigma \exp(-Q_1/RT) + B\sigma^{4.4} \exp(-Q_2/RT)$. The apparent activation energy for creep in the viscous region is a sensitive function of the oxygen-to-metal ratio, with a maximum at ~1.985. This behavior may be explained on the basis of the diffusion of cation vacancies that control the creep deformation in mixed oxides with an oxygen-to-metal ratio >1.985. However, at low oxygen-to-metal ratios, the creep deformation may be controlled by the diffusion of the cation interstitials. (auth)

2880 EFFECT OF NEUTRON IRRADIATION ON ALUMINA-COATED BeO. Reeve, K. D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). J. Nucl. Mater.; 44: No. 3, 285-94(Sep 1972).

Thirty-eight one-inch diameter BeO spheres with 200 to 300 μm thick bonded alumina coatings were irradiated at various temperatures between 75 and 100°C and 830°C to integrated fast neutron fluxes up to 4.8×10^{20} nvt. The diameters of all spheres were measured before and after irradiation, representative spheres were examined in cross-section metallographically and six irradiated spheres were corrosion tested in moist air at 1200 or 1300°C. Spheres irradiated to 2.2×10^{20} nvt at 75 to 100°C and 3.0×10^{20} nvt at 830°C had intact coatings showing no sign of cracking. At higher doses the coatings were still intact but showed poor protective behavior in corrosion tests. Metallographic examination showed that such spheres had radial cracks in the coating which allowed access of moisture to the BeO. The observed increases in diameter and the threshold doses for cracking were in qualitative agreement with predictions made from the known neutron-induced expansion behavior of BeO and Al_2O_3. The role of chrysoberyl ($BeO \cdot Al_2O_3$), which forms a thin reaction zone between the BeO and the coating during fabrication, is certainly important, but is more difficult to explain. (auth)

2881 POLYMORPHIC TRANSFORMATION OF NIOBIUM PENTOXIDE. Rozhenko, S. P.; Kvashenko, A. P. (Inst. of General and Inorganic Chemistry, Kiev). Ukr. Khim. Zh.; 38: No. 8, 819-21(Aug 1972). (In Russian).

Samples of niobium hydroxide (oxide) obtained from various sources were investigated by chemical, thermogravimetric, thermographic, electrographic, and x-ray methods. Thermal treatment at 600 to 840°C of the hydroxide produced α Nb_2O_5 or a mixture of modifications, depending on the source of the hydroxide. The α-Nb_2O_5 was metastable and at 850° was converted to the stable β-Nb_2O_5. The existence of the α- and β-modifications of Nb_2O_5 was confirmed. (tr-auth)

2882 HIGH-TEMPERATURE CREEP OF ZIRCONIUM CARBIDE. Miloserdin, Yu. V. Probl. Prochnosti; No. 3, 50-3(Mar 1972). (In Russian).

The results of some creep tests on ZrC samples at 2400 to 2800°K are presented and analyzed. The behavior of ZrC in the three conventional stages of creep undergoes very substantial changes and in this respect it differs appreciably from that of pure metals. Over the temperature range studied and under stresses of 0.3 to 1 kg/mm² the steady state of creep in ZrC is mainly determined by a diffusion process. The activation energy of diffusion is ~120 kcal/mole. (Metals Abstr.)

2883 BORON–ALUMINUM STRUCTURAL COMPONENT FOR SHUTTLE. Brown, E. P.; Hepper, R. H. SAMPE Quart.; 9: No. 4, 12-16(Jul 1972).

A boron-aluminum structural component, representative of Space Shuttle fuselage structure, has been fabricated and tested as part of a program to demonstrate boron-aluminum feasibility for shuttle applications. The 4 by 5-foot component consists of eleven 24-ply Z section stringers and a +45 degree 8-ply skin. It was tested at room temperature and at 500°F under combined compressive and shear loadings. The components for this program were fabricated in our production facility, in order to encounter and solve scale-up problems, and to obtain test data representative of production hardware. The data from this program will allow us more accurately to predict weights and costs of boron-aluminum structures for the Space Shuttle. (auth)

2884 THERMAL CONDUCTIVITY OF HIGH-MELTING COMPOUNDS. Taubin, M. L.; Andrievskii, R. A.; Rymashevskii, G. A. High Temp. (USSR) (Engl. Transl.); 10: No. 1, 163-5 (1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 187-9(1972).

The change in the thermal conductivity of high-melting compounds, carbides, nitrides, borides, silicides, oxides, etc., was examined as a function of their characteristic temperature (θ). In calculations carried out for eight carbides, five nitrides, three borides, five oxides, and two silicides of the transition metals, values of the thermal conductivity taken earlier were used. The results are given and it is evident that the nonmono-

tonic character of the dependence of the reduced thermal conductivity (λ/λ_θ) on the reduced temperature (T/θ): $\lambda/\lambda_\theta = A(T/\theta)^r \exp[\tau(T/\theta)]$, where A, r, and τ are coefficients, taking on different values in the intervals $0.1 \leq T/\theta \leq 0.7$ and $0.7 \leq T/\theta < 5$. (auth)

2885 MEASUREMENT OF THE ENTHALPY OF FUSED BORON OXIDE AT HIGH TEMPERATURES. Shpil'rain, E. E.; Kagan, D. N.; Barkhatov, L. S. (Inst. of High-Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 10: No. 1, 171-2(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 193-5(1972).

The enthalpy of B_2O_3 was measured by the mixing method in a boiling calorimeter. At temperatures up to 1000°K, a furnace was used having wire-type Mo heaters in an alundum housing, while at higher temperatures it had heaters in the form of a cylindrical set of tungsten rods. At the interval from 760 to 1000°K the enthalpy was investigated using sealed ampoules of stainless steel, while in the interval 1000 to 2210°K they were made of fused Mo. (M.O.W.)

2886 METHOD FOR DETERMINING PARTICLE SIZE. Abdel-Azim, M. S.; Vlajic, M. (Atomic Energy Establishment, Cairo). J. Amer. Ceram. Soc.; 55: No. 10, 535(Oct 1972).

A method for dispersing powders for examination by transmission electron microscopy is described. The apparatus consists of a glass column 200 mm high and 40 mm in diameter. The column contains the powder suspension and is fitted near the bottom with a porous glass filter. Air is blown through the bottom and the flow is adjusted to obtain bubbles free from liquid entrapment. Operation of the apparatus is illustrated using UO_2 powder. (J.R.D.)

2887 ACTIVATED SINTERING OF ThO_2 AND ThO_2–Y_2O_3 WITH NiO. Halbfinger, G. P.; Kolodney, M. (City Coll., New York). J. Amer. Ceram. Soc.; 55: No. 10, 519-24(Oct 1972).

The effect of additives on the sintering of ThO_2 and ThO_2–Y_2O_3 compacts and loose powders was studied by isothermal shrinkage measurements and by scanning electron micrography. Small amounts of the oxides of Ni, Zn, Co, and Cu reduced the sintering temperature. The behavior of NiO at a concentration of 0.8 wt % (2.4 mol %) was studied in detail and found to yield high-density bodies at temperatures below 1500°C. The presence of Y_2O_3 as a separate phase increases the rate of sintering of ThO_2, but smaller amounts of NiO are much more potent. The major portion of the densification occurs very rapidly and is followed by a much slower sintering process typical of volume diffusion. The fast early shrinkage may be caused by the capillary forces of a liquid, but since no evidence of melting was found, a solid-state mechanism may be responsible. (auth)

2888 PHASE EQUILIBRIA IN THE SYSTEM SrO–CdO–V_2O_5. Brown, J. J. Jr. (Virginia Polytechnic Inst. and State Univ., Blacksburg). J. Amer. Ceram. Soc.; 55: No. 10, 500-3(Oct 1972).

Phase equilibria in the system SrO–CdO–V_2O_5 in air were established from data obtained by DTA, quenching, and high-temperature solid-state reaction experiments. The SrO–V_2O_5 boundary system contains 4 compounds at SrO to V_2O_5 molar ratios of 4:1, 3:1, 2:1, and 1:1. A fifth compound with a molar composition of ≈10:3 with the apatite crystal structure was also found; it may, however, be a hydroxyapatite phase. The CdO–V_2O_5 system contains the compounds $3CdO \cdot V_2O_5$, $2CdO \cdot V_2O_5$, and $CdO \cdot V_2O_5$. The latter compound exhibits a rapid reversible polymorphic transition at 180°C. Complete solid solubility exists in the SrO–CdO system. The most probable compatibility relations were determined from the data available for the SrO–CdO–V_2O_5 ternary system. Limited solid solubility exists between $SrO \cdot V_2O_5$ and $CdO \cdot V_2O_5$, and the high-temperature $CdO \cdot V_2O_5$ polymorph is stabilized to room temperature by solid solution of $SrO \cdot V_2O_5$. Evidence for the existence of 2 ternary compounds with limited local solid solubility is also presented. (auth)

2889 PREPARATION AND MAGNETIC PROPERTIES OF THE GLASSY SYSTEM MnO–Fe_2O_3–B_2O_3. Sestak, J.; Zaveta, K.; Roskovec, V.; Zounova, F. (Inst. of Solid-State Physics, Prague). J. Amer. Ceram. Soc.; 55: No. 10, 537(Oct 1972).

Mixes of pure Fe_2O_3, Mn_2O_3, $MnCO_3$, and H_3BO_3 were ball milled for about 10 h and reacted at about 900° then heated to about 50° above the melting temperature of the mix. The melt was cast onto stainless steel plate and rolled to about 2 mm thickness. The magnetic properties were measured by a ballistic method in a superconducting solenoid yielding fields up to 50 kOe. (J.R.D.)

2890 PHASE EQUILIBRIA IN THE SYSTEM CaO–BaO–WO_3. Kreidler, E. R. (General Electric Lighting Research Lab., Nela Park, Cleveland). J. Amer. Ceram. Soc.; 55: No. 10, 514-19(Oct 1972).

The 1200°C isothermal section of the system CaO–BaO–WO_3 was studied in detail. The system contains one ternary compound, Ba_2CaWO_6, which can exist in binary equilibrium with BaO, CaO, Ba_3WO_6, Ba_2WO_5, $BaWO_4$, and Ca_3WO_6. The composition range of solid solutions based on the ternary compound extends from Ba_2CaWO_6 to $Ba_{1.86}Ca_{1.14}WO_6$ at 1200°C. Solid solubility along the binary join $BaWO_4$–$CaWO_4$ was studied in the interval 1000 to 1340°C. Maximum solid solubilities occur at the eutectic temperature (1340 ± 10°C) and are 18 mole% $CaWO_4$ in $BaWO_4$ and 3.5 mole% $BaWO_4$ in $CaWO_4$. A phase diagram is given for the $BaWO_4$–$CaWO_4$ system. Evidence is presented which shows that Ba_2WO_5 is a stable phase, and the BaO–WO_3 phase diagram is revised accordingly. There are 3 polymorphs of Ba_2WO_5 related by rapid reversible inversions at 1385 ± 5° and 1490 ± 10°C. The low-temperature form of Ba_3WO_6 is tetragonal (a = 8.65(2) Å and c = 16.43(4) Å), not cubic as previously reported. The compounds Ca_6WO_9, BaW_2O_7, $BaCa_2WO_6$, $Ba_5CaW_2O_{12}$, and $Ba_{1.5}Ca_{1.5}WO_6$ reported in earlier studies were not confirmed. (auth)

2891 SINTERING PROCESSES IN CARBIDE–COBALT ALLOYS WITH 0.2 TO 15 PERCENT COBALT. Jung, O.; Kohlhaas, E.; Dawihl, W.; Peter, W. (Roechling'sche Eisen- und Stahlwerke GmbH, Voelklingen, Ger.). Z. Werkstofftech.; 2: No. 7, 345-55(1972). (In German).

The sintering process in alloys consisting of 0.2, 0.5, 3, 6, and 15% cobalt, the remainder being either WC, TiC, WC/TiC, or WC/TiC/TaC, were observed after annealing at 400°C to 1500°C by measuring the bending strength at rupture, the magnetic saturation, the specific electric resistance and the coercive force at room temperature. As early as the grinding stage the WC–Co-compounds can be clearly distinguished from all other blendings. Thin, not necessarily coherent, layers of Co form on the tungsten carbides, a fact which is indicated by the higher coercive force and bending strength at rupture of the WC–Co-green compacts. The actual sintering process can be divided into four temperature ranges: (1) under 400°C, (2) 400 to 800°C, (3) 800°C until liquid phase, and (4) T over liquid phase. (GF)

2892 V_2O_5–MoO_3 SYSTEM. Volkov, V. L.; Tynkacheva, G. Sh.; Fotiev, A. A.; Tkachenko, E. V. (Inst. of Chemistry, Ural, USSR). Zh. Neorg. Khim.; 17: No. 10, 2803-5(Oct 1972). (In Russian).

A phase composition diagram was constructed for the V_2O_5–MoO_3 system under an atmosphere of normal air. Two eutectics at 644 and 652°C were found. The fusion of samples was accompanied by absorption of oxygen, which was then released upon crystallization. (tr-auth)

2893 PHASE DIAGRAM OF THE MoO_3–SrO SYSTEM. Zhukovskii, V. M.; Yanushkevich, T. M.; Tel'nykh, T. F. (Ural State Univ., USSR). Zh. Neorg. Khim.; 17: No. 10, 2827-30 (Oct 1972). (In Russian).

The phase diagram of the MoO_3–SrO system was investigated up to a temperature of 1,600°C. The existence of two compounds was established: $SrMoO_4$, congruently melting at 1,457°C, and Sr_3MoO_6 with a melting point <1,600°C. The methods used included differential thermal analysis, visual-polythermal, x-ray, densitometric, and electric resistance. (tr-auth)

2894 PHASE EQUILIBRIA IN THE SYSTEM HfO_2–Yb_2O_3. Perova, E. B.; Samoilenko, A. A.; Spiridonov, F. M.; Komissarova, L. N. (Moscow State Univ.). Zh. Neorg. Khim.; 17: No. 10, 2846-7(Oct 1972). (In Russian).

Reactions between HfO_2 and Yb_2O_3 in the temperature interval 1,000 to 1,800°C were studied, and a phase diagram was constructed. No compounds were detected, but broad fields of solid solutions and two-phase regions of their coexistence were observed. (tr-auth)

2895 CONTACT INTERACTION OF REFRACTORY COMPOUNDS WITH LIQUID METALS. COMMUNICATION II. Samsonov, G. V.; Panasyuk, A. D.; Kozina, G. K.; D'yakonov, L. V. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 35-7(Aug 1972). (In Russian).

Interaction between liquid metals from the iron family and carbides of metals from subgroups Va to VIa was investigated. A chemical interaction was established to take place within these systems accompanied by formation of limited solutions and eutectic alloys. Investigation of the contact zone in the Mo_2C–Fe system by means of x-ray spectrum analysis showed that in the given system iron is dissolved in molybdenum carbide with formation of a limited solid solution. (auth)

2896 EFFECTS OF SINTERING MEDIUM ON QUALITY OF HARD CERAMIC ALLOYS CONTAINING CARBIDES OF ZIRCONIUM AND HAFNIUM. Chaplygin, F. I.; Vitryanyuk, V. K.; Morozov, V. V. (Kiev Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 81-4(Aug 1972). (In Russian).

The conditions for obtaining hard alloys containing complex carbide $ZrC_{x\leq1}$–WC and $HfC_{x\leq1}$–WC were studied in various

media. It was established that sintering in industrially pure hydrogen and argon medium results in oxidation of the alloys and destruction of the samples because of the presence of water and oxygen vapors in the melting chamber of the furnace. Alloys qualitative in structure and density may be obtained by sintering in spectrally pure hydrogen medium and in vacuum. (auth)

2897 SOME DURABILITY PROPERTIES OF GRAPHITE–ZIRCONIUM CARBIDE COMPOSITE MATERIALS. Dergunova, V. S.; Shurshakov, A. N.; Posos'eva, G. D.; Lutsenko, L. N. Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 51-8(Aug 1972). (In Russian).

The results of studies on the physicomechanical properties of composite materials graphite–zirconium carbide and graphite–zirconium carbide–zirconium, which differ by chemical composition and structure, are presented. The durability properties were found to depend on the structure of the materials, durability of forming phases, adhesion strength on the interface, volumetric ratio, and coefficients of thermal expansion of phases as well as on a number of residual pores and their shape. It was established that when changing the degree of zirconium phase saturation with carbon, the properties of the composition can be considerably altered. With the presence of residual zirconium the tension and bending strength is 1.5 to 3 times as high as in complete carbidization. (auth)

2898 SOME TECHNOLOGICAL FACTORS INFLUENCING THE VISCOSITY OF THERMOPLASTIC SLURRY AND PROPERTIES OF FINISHED NIOBIUM CARBIDE-BASE ARTICLES. Avgustinik, A. I.; Ordan'yan, S. S.; Kudryasheva, L. V.; Vigdergauz, V. Sh. (Leningrad Technological Inst.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 16-20(Aug 1972). (In Russian).

The method of hot slurry molding under pressure was used for the first time to obtain niobium carbide articles of complex form. The effects of binder (paraffin) concentration, NbC dispersity (up to 3.2 m^2/g), and temperature on the slurry viscosity (one of the most important technological factors determining the ability of slurry to fill complex metal molds under pressure) were studied. An effect of dispersity, binder concentration was studied as applied to the most important ceramic properties of the sintered articles, i.e., shrinkage, porosity, and density. (auth)

2899 HIGH-TEMPERATURE OXIDATION OF OXYCARBIDES, OXYNITRIDES, AND OXYCARBONITRIDES OF ZIRCONIUM AND HAFNIUM. Zhilyaev, V. A.; Zainulin, Yu. G.; Alyamovskii, S. I.; Shveikin, G. P. (Inst. of Chemistry, Sverdlovsk, USSR). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 38-43(Aug 1972). (In Russian).

The process of oxidation of powdered oxycarbides, oxynitrides, and oxycarbonitrides of Zr and Hf in air was studied up to 950°C. It is suggested that oxidation of carbides and oxycarbides proceeds through a common intermediate, MeO_2C, wherein Me = Zr or Hf. (tr-auth)

2900 STANDARD HEAT OF FORMATION OF HAFNIUM DIOXIDE. Kornilov, A. N.; Ushakova, I. M. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 200: No. 6, 1382-4(21 Oct 1971). (In Russian).

The heat of formation of HfO_2 was determined by direct combustion of a sample of α-Hf in which the chief impurity was 0.79 weight % Zr. All other elements were present in <0.04%. Five combustions were averaged to yield the value: Hf (crystal α-form) – O_2 (gas) → HfO_2 (monoclinic), for which $\Delta H^0_{298°K} = -267.1 \pm 0.5$ kcal. (K.S.W.)

2901 EFFECTS OF VOID MIGRATION PROCESS ON FISSION GAS RELEASE. Doi, Akira (Hitachi Ltd., Kawasaki, Jspan); Hayashi, Hiroshi. J. Nucl. Sci. Technol. (Tokyo); 9: No. 9, 505-11(Sep 1972).

The release rate of fission-gas from UO_2 was continuously measured during irradiation in the Hitachi Training Reactor. The UO_2 specimen was heated electrically in in-core assemblies by tungsten heaters, either arranged axially transversing the specimen (producing radial temperature gradient) or cylindrically outside the specimen (uniform heating). In a case of the axially heated annular UO_2 pellets with radial temperature gradient, the rate of fission-gas release increased with time under constant temperature and flux. This experimental result was explained by considering as fission gas release mechanism a combination of diffusion and pore migration processes. On the other hand, when UO_2 pellets were heated isothermally up to 2,000°C, the fission-gas release rate could be explained in terms of diffusion process alone. No effect of equiaxial grain growth was observed on the rate of fission-gas release. (auth)

2902 IMPROVEMENTS IN CERAMIC FISSILE MATERIALS. Rigby, Frank; Ainscough, John Brian (to United Kingdom Atomic Energy Authority). British Patent 1,285,190. 9 Aug 1972. Filed 16 Dec 1968.

Reference is made to the production of ceramic nuclear fuels, such as UO_2 and/or PuO_2, containing small amounts of additive oxides to inhibit release of gaseous fission products. In the method described UO_2 containing an additive soluble in the hyperstoichiometric oxide but insoluble in the stoichiometric or hypostoichiometric oxide is sintered in an oxidizing atmosphere to bring the additive into hyperstoichiometric solution and the sintered material is then heated in a reducing atmosphere to convert the UO_2 to a form in which the additive is insoluble but is dispersed in fine particulate form. The additive may consist of MgO in the range 0.15 to 3.7 weight %, or Al_2O_3 in the range 0.15 to 3.3 weight %. The oxidizing atmosphere may comprise CO_2 in the temperature range 1200 to 2000°C, and the reducing atmosphere H_2 at a temperature below the sintering temperature, to convert the material to the stoichiometric form. (UK)

2903 INTERACTION BETWEEN Ln_2O_3 AND HfO_2. Krzhizhanovskaya, V. A.; Glushkova, V. B.; Shcherbakova, L. G. (Inst. of Chemistry of Silicates, Leningrad). Dokl. Akad. Nauk SSSR; 204: No. 1, 107-9(1 Mar 1972). (In Russian).

The diffusion of oxides of Nd, Sm, Dy, Yb, and HfO_2 at 1800°C in polycrystalline samples was observed with the aid of an x-ray microprobe apparatus. Microphotographs of oxide pairs are reproduced and discussed. Quantitative work on the Ln_2O_3–HfO_2 pair yielded data on the concentration distribution of Ln and Hf in boundary regions of samples heated for 3 h at 1800°C. (K.S.W.)

2904 PHASE EQUILIBRIA OF THE CaO–TiO_2–V_2O_5 SYSTEM. Solacolu, S.; Zaharescu, M. (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 17: No. 10, 1715-21(Oct 1972).

The phase equilibrium diagram of the system CaO–TiO_2–V_2O_5 was established and the limit curves that delimit the areas of primary crystallization of phases and the invariant points were determined. It was established that no ternary compounds are formed in this system. The formation of binary definite compounds that arise in the frame of the ternary system was also studied. (auth)

2905 HIGH TEMPERATURE ENTHALPY AND RELATED THERMODYNAMIC FUNCTIONS OF NON-STOICHIOMETRIC URANIUM OXIDES. Marchidan, D. I.; Ciopec, M. (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 17: No. 10, 1657-67(Oct 1972).

High temperature enthalpies of non-stoichiometric uranium oxides $UO_{2.21}$ and $UO_{2.366}$ were measured over a temperature range from 300 to 1300°K using a drop calorimeter. The sample encapsulated into the platinum container under vacuum was dropped into a copper block calorimeter with isothermal jacket in order to measure the heat released which was thereafter converted into enthalpies. The least square analysis of the experimental enthalpies data was performed with TERMOX computer program on an IBM System 360/30 computer. With this program four polynomial equations were smoothed from the experimental results. Out of these relations only one was preferred which produces the best fit. Smoothed values of the enthalpies and related thermodynamic functions were calculated and are tabulated at round temperatures. (auth)

2906 ALLOYS HfB_2 AND ZrN. Medvedeva, O. A. (Inst. of Problems in Material Studies, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 4, 673-4(Apr 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 4, 773-4(Apr 1972).

The properties of sintered HfB_2–ZrN specimens were studied. HfB_2 and ZrN powders were mixed in ratios corresponding to contents of 1, 2, 3, 10, 20, 40, 50, 60, 70, 80, 90, 95, and 98 mole % of each component and then sintered by hot pressing in graphite molds. The effects of sintering parameters and composition on the electric and physical properties of the specimens are reported. (T.F.D.)

2907 CHEMICAL STABILITY OF BORIDES OF TRANSITION METALS OF GROUPS IV–VI IN ALKALINE SOLUTIONS. Kugai, L. N. (Inst. of Problems in Materials Science, Kiev). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 4, 669-70(Apr 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 4, 769-70(Apr 1972).

The chemical stability of transition metal borides in 5 and 20% NaOH solutions is reported. Addition of oxidizing agents (bromine water, hydrogen peroxide) to the NaOH solutions accelerated the decomposition of virtually all the borides. (T.F.D.)

2908 THERMAL CONDUCTIVITY OF COMPACT SPECIMENS OF CUBIC BN. Makedon, I. D.; Petrov, A. V.; Fel'dgun, L. I. (Inst. of Semiconductors, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 4, 665-6(Apr 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 4, 765-6(Apr 1972).

Temperature dependence of thermal conductivity of cubic boron nitride is shown from 80 to 1000°C. (T.F.D.)

2909 SOLID SOLUTIONS IN THE SYSTEMS ZrO_2–Yb_2O_3 AND ZrO_2–Y_2O_3–Yb_2O_3. Kuznetsov, A. K.; Krasil'nikov, M. D.; Tikhonov, P. A. (Inst. of Silicate Chemistry, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 4, 650-3(Apr 1972).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 4, 749-52(Apr 1972).

Solid solutions in the system $ZrO_2-Y_2O_3-Yb_2O_3$ were investigated in connection with the search for new materials with high refractoriness and good electric properties. The kinetics and formation mechanism of the solid solutions and the change in their properties with gradual replacement of Y_2O_3 with Yb_2O_3 were studied. The rate of formation of solid solutions in the system $ZrO_2-Y_2O_3-Yb_2O_3$ is limited by the rate of volume diffusion of the initial components through the reaction product. Isomorphous replacement of Y^{3+} with Yb^{3+} takes place in the solid solution in the system $ZrO_2-Y_2O_3-Yb_2O_3$. Solid solutions based on ZrO_2, stabilized with Yb_2O_3 or by a mixture of Y_2O_3 and Yb_2O_3, are stable up to 2200°C. (T.F.D.)

Metals and Alloys

Refer also to abstracts 2872 and 4433.

Corrosion and Erosion

Refer also to abstract 2861.

2910 (Y-DA-4815) STUDIES OF OXIDE AND FLUORIDE FILMS ON METALS USING AN ION MICROPROBE MASS ANALYZER. Cristy, S. S.; Ferree, D. V.; Nolan, T. A.; McCulla, W. H. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 16 Oct 1972. Contract W-7405-eng-26. 17p. (CONF-721025-10). Dep. NTIS.

From sixteenth conference on analytical chemistry in nuclear technology; Gatlinburg, TN. (24 Oct 1972).

The ion microprobe uses a mass analyzed ion beam to sputter atoms, molecules, and ions from the surface of the material being studied. The sputtered ions are collected and mass analyzed. Mass analysis allows the determination of isotopic abundance and sensitivity to all elements. The ions sputtered contain simple molecular ions and molecule fragment ions as well as atomic ions. In the sputtering process, ions arise from only the first few atomic layers at the surface, thus allowing the determination of composition as a function of depth in rather thin films. The mobile species in the reactions of oxygen and fluorine with nickel were determined using the ion microprobe. "A" nickel foils were coated with 100 Å of ^{62}Ni and then reacted with oxygen or fluorine. By sputtering through these films and making depth profiles of the $^{62}Ni/^{58}Ni$ ratios, data were obtained which indicate that fluorine diffuses through the NiF_2 film to react with Ni at the NiF_2–Ni interface; and that Ni diffuses through the NiO film to react with oxygen at the O_2–NiO interface. Diffusion in the oxidation of Mulberry, an alloy of U, 7.5% Nb, 2.5% Zr, is also being studied. This work, including determination of oxide film thickness and analysis of inclusions in Mulberry, is discussed. (auth)

2911 HIGH-TEMPERATURE SODIUM INDUCED CHANGES IN INCONEL 718 BRAZEMENT MICROSTRUCTURES. Whitlow, G. A. (Westinghouse Electric Co., Madison, Pa.); Berkey, E. pp 303-11 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

A nickel-chromium base alloy (Inconel 718) with a nickel-chromium phosphorus braze (Nicrobraz 50) was one of the material combinations considered for fuel element grids in sodium cooled reactors. Simulated brazed, fuel pin, grid type jointures were exposed to high temperature (900 to 1200°F), low oxygen, flowing sodium in a small test loop system designed to approximate major reactor operating parameters. The effects of long-term (3500 hours) exposure to sodium on the microstructure and composition of both the grid and braze materials have been examined by conventional metallography and scanning electron microscopy. In the higher temperature region, the surface of the Inconel 718 suffered intergranular attack and sodium preferentially attacked the phosphorus-containing second phase in the braze metal. Precipitation of discrete adherent particles occurred on the surface of the 900°F samples. X-ray analysis revealed that exposure to 1200°F sodium removed both nickel and chromium from the Inconel 718 surface and that the surface deposits formed at 900°F were rich in manganese and chromium. Similarly, the braze was found to have lost phosphorus from the exposed surface at the higher temperature and to have been coated with manganese-rich deposition products at 900°F. (auth)

2912 OXIDATION KINETICS OF SiC POWDER BETWEEN 1200 AND 1600°C. Ebi, R.; Fitzer, E.; Huettinger, K. J. (Univ., Karlsruhe, Ger.). High Temp. - High Pressures; 4: No. 1, 21-5(1972). (In German).

The overall rate of the heterogeneous gas-solid reaction during the high-temperature oxidation of small SiC-particles by oxygen is strongly influenced by the total height of the layer of the carbide powder, used as sample material in the kinetic experiments. The low viscosity of the silica-glass oxidation product causes the sintering of the previously nonsintering SiC powder, especially above 1400°C, and leads to a reduction of the free surface. Since earlier workers have used the original powder surface as basis for the evaluation of the reaction kinetics from experimental data, the oxidation rates reported by them should be corrected in the direction of higher values. The present results are compared with literature data. On using the effective (maximum) reaction rate, the Arrhenius plot of the oxidation rate of SiC exhibits different activation energies below and above 1400°C. This result is in agreement with the results for the oxidation rate of $MoSi_2$. An activation energy of 56 kcal $mole^{-1}$ for the SiC oxidation was found above 1400°C. The rate-controlling oxygen transport through the oxidation product seems to be favored by crystalline domains within the glass, consisting of α-cristobalite. (auth)

2913 EFFECTS OF INTERNAL OXIDATION ON CONTACT RESISTANCE OF Ag–Be ALLOYS. Kimata, H.; Nishi, S. (Nagoya Univ., Japan). J. Jap. Inst. Metals; 36: No. 9, 846-52(Sep 1972). (In Japanese).

Silver alloys containing 0.10, 0.20, 0.45, and 0.56 wt % Be were heated at 820°C in $\sim 10^{-3}$ mm Hg or in still air for 2 ~ 16 h. The contact resistance was measured at the surface as-heat treated and 0.20 mm scraped from the surface. The results showed that resistivity of internally oxidized samples was higher than the non-oxidized one. On oxidizing, the resistivity of Ag–0.20 wt % Be changed from 1.9×10^{-6} to 2.2×10^{-6} Ω-cm and that of Ag–0.45 wt % Be from 2.0×10^{-6} to 3.0×10^{-6} Ω-cm. In Ag–0.10 ~ 0.45 wt % Be alloys the contact resistance on the surface as-heat treated in a $\sim 10^{-3}$ mm Hg atmosphere was higher than that of the heat-treated specimens in still air. In Ag–0.10 ~ 0.45 wt % Be alloys the contact resistance on the surface as-heat treated in still air was almost equal to that of pure silver. Contact resistance at the position 0.2 mm below the surface was nearly equal to that of pure silver in the case of both heat treatments, except for Ag–0.45 wt % Be alloy. Contact resistance of Ag–0.45 wt % Be internally oxidized was higher than that of the non-oxidized. The relation between contact resistance and load was generally expressed by $R = K \cdot P^m$. The value of m for the position 0.2 mm below the surface was determined as about $-1/3$ at the loads from 50 to 1000 g. (auth)

2914 EFFECTS OF ALLOYING ELEMENTS ON THE PITTING CORROSION OF ALUMINUM. Sugimoto, K.; Sawada, Y.; Morioka, S. (Tohoku Univ., Sendai). Trans. Jap. Inst. Metals; 13: No. 5, 345-51(Sep 1972).

The effects of alloying elements on the pitting corrosion of aluminum in a 1 N NaCl solution have been studied by using binary aluminum alloys containing different amounts of alloying elements, Fe, Si, Cu, Mg, Mn, Ni, V, Cr, B, Zr, Ti, and Be. Anodic and cathodic polarization curves, pitting potentials, pitting dissolution currents, and densities of pits at constant potentials were measured in the solution, and relations between the corrosion resistance and these properties of the alloys were considered. For increasing the resistance of the alloys against pitting corrosion, it was effective to add the elements which serve to increase the cathodic polarization. This is because the dissolution rate of the alloys in the immersion corrosion test was dependent upon the degree of cathodic polarization and independent of the anodic dissolution rate and the pitting potential. (auth)

2915 HIGH TEMPERATURE OXIDATION OF Ti–15 Mo–5 Zr ALLOY AT LOW PRESSURE OF OXYGEN ($4 \times 10^{-5} \sim 2 \times 10^{-4}$ TORR). Nagasaka, M.; Shikano, Y.; Yamashina, T. (Hokkaido Univ., Sapporo). J. Jap. Inst. Metals; 36: No. 9, 865-8(Sep 1972). (In Japanese).

The oxidation kinetics of Ti–15 Mo–5 Zr alloy at low oxygen pressure of 4×10^{-5} to 2×10^{-4} torr was studied in the temperature range of 500 to 900°C by means of a microbalance. The results showed that the oxidation proceeded according to linear rate law for about six hours under the experimental condition of 600 to 900°C and 4×10^{-5} to 2×10^{-4} torr. The oxidation rate of the alloy was observed to be lower than that of pure titanium at 700°C for each pressure. The linear rate constant was proportional to oxygen pressure at each temperature, and therefore, the ratio of linear rate constant to oxygen pressure was found to be constant at each temperature, i.e., 7.9×10^{-5} for 600°C, 7.0×10^{-5} for 700°C, 6.4×10^{-5} for 800°C, and 6.3×10^{-5} ($g \cdot cm^{-2} \cdot sec^{-1} \cdot torr^{-1}$) for 900°C,

respectively. As is obvious from these values, abnormality was recognized in the temperature dependency on oxidation rate, that is, the rate decreased as the oxidation temperature increased. The dependency of oxygen pressure on the oxidation rate is discussed on the assumption that the adsorption process of oxygen onto the metal surface might be the rate determining. (auth)

2916 OXIDATION OF METALS AND ALLOYS. Papers Presented at a Seminar of the American Society for Metals, Metals Park, Ohio, October 17–18, 1970. Metals Park, Ohio; American Society for Metals (1971). 281p.

Eleven chapters are included on: absorption of oxidant and oxide nucleation; structure and properties of thin oxide films; oxidation in the thin-film range; thermochemistry and gas-metal reactions; simultaneous oxidation and chlorination of Ni; ternary diffusion and its relationship to oxidation and sulfidation; transport properties and defect structures of oxide scales; exfoliation and the mechanical behavior of scales; influence of external electric fields on oxidation; oxidation of alloys; structures of thick scales on alloys; and internal oxidation. A subject index is given. (P.C.H.)

Preparation and Fabrication

2917 (AEC-tr-7343) TESTING OF WELDABILITY IN PRACTICE: YESTERDAY, TODAY, AND TOMORROW. Soete, W. Translation of a German report. 17p. Dep. NTIS.

A review of methods for evaluating material weldability is presented. Earlier theory and technology related to material strength are reviewed and needs for development of new tests are discussed. Proposals for new tests are listed. (J.R.D.)

2918 (JEN-236) FABRICATION OF FUEL ELEMENTS FOR THE SWIMMING POOL REACTOR JEN-1. de Villota Ruiz, P.; Esteban Hernandez, J. A.; Clemente Casado, J. M.; Diaz Diaz, J. (Junta de Energia Nuclear, Madrid (Spain)). 1972. 67p. (In Spanish). Dep. NTIS (U. S. Sales Only).

An aluminothermic method using pressure and high temperature for the preparation of UAl_3 is briefly described. It is followed by the description of a fabrication and assembly method for plate-type fuel elements, as well as an economical study of the whole process. (auth)

2919 (JPRS-57364) URANIUM AND ITS ALLOYS. Sokurskii, Yu. N.; Sterlin, Ya. M.; Fedorchenko, V. A. Translated from pp 5-66; 331-437 of Uran i Ego Splavy, Atomizdat, Moscow, 1971. 229p. NTIS.

Chapters from the original book dealing only with the production and fabrication of uranium and its alloys are presented. The chapters are entitled: Applications of Uranium and Its Alloys; Uranium Dioxide and Uranium Tetrafluoride Production Processes; Metallic Uranium Production; Refining of Raw Uranium and Powder Metallurgy of Uranium; Melting and Casting; Pressing of Solid and Hollow Profiles; Shape and Flat Rolling; Finishing Processes in the Manufacture of Uranium Products; and Manufacture of Fuel Elements. (T.F.D.)

2920 (Y-1846) INFILTRATION OF METALLOGRAPHIC SPECIMENS WITH METALLIC ALLOYS. Rose, E. T.; DeRoos, L. F. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 18 Oct 1972. Contract W-7405-eng-26. 14p. Dep. NTIS.

A simplified technique has been devised for infiltrating porous and particulate materials with a metallic alloy for metallographic processing. This technique has been found suitable for processing production quantities of metallographic specimens for microexamination and electron microprobe analysis. (auth)

2921 RECOVERY IN BERYLLIUM FOIL. Brewer, A. W.; Avery, J. G.; Fraikor, F. J. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. pp 41-7 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

The recovery behavior of 0.015 inch thick beryllium foil rolled from vacuum cast ingots was investigated as a function of the amount of foil reduction, rolling temperature, and annealing time and temperature. The microstructure was examined by optical and electron transmission microscopy and the results were correlated with Knoops microhardness data. The preliminary results indicate that complete recovery did not occur in foils with less than 15% reduction at annealing temperatures of less than 675°C. (auth)

2922 SCANNING ELECTRON MICROSCOPY OF FRACTURES IN WELDED STRUCTURES. Lundin, C. D. (Univ. of Tennessee, Knoxville); Bennett, R. K. pp 243-50 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

The scanning electron microscope has been used to observe and characterize the morphology of the surfaces of weld defects, discontinuities, and fractures. These observations and characterizations have enabled the definition of the mechanism of formation of weld defects and have provided information as to the factors leading to the formation of weld fractures. In nickel-base alloys hot cracking is easily and clearly recognized by scanning electron fractography. In most cases a liquid film is an integral part of the cracking mechanism, and other evidence suggests that at times two liquid films of differing compositions and properties play a part in the mechanism of crack formation. Evidence is also available which suggests the possibility of a stress-rupture mechanism of hot crack formation in which a previously solidified film plays a role. In molybdenum and molybdenum base alloys, clear evidence has been obtained that the majority of hot crack formations during welding is influenced by liquid films. A second mechanism of elevated temperature fracture in these alloys has been determined to result from void formation on grain boundaries and link-up of voids to form microfissures and subsequent boundary fracture. (auth)

2923 ELECTROPOLISHING OF CHEMICAL VAPOR DEPOSITED TUNGSTEN. Rahe, A. H.; Stablein, P. F. Jr. (Bendix Corp., Kansas City, Mo.). pp 257-64 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

A detailed study was made using the electropolishing process to reveal various microstructures in chemical vapor deposited tungsten. The voltage-current relationship was established and a voltage range was found for revealing in the microstructure markings produced by plating parameter changes. Surface microtexture produced by the several polishing procedures was correlated with deposit hardness and reaction gas supply conditions. (auth)

2924 DIGITAL CONTROL FOR GAUGING AND ROLLING ULTRA-THIN SHEET MATERIAL. Hunter, Larry (Arnold Engineering Co., Marengo, Ill.). Int. J. Nondestruct. Test.; 4: No. 2, 167-70(Sep 1972).

A system for producing high-quality ultra-thin foils is described. The system is composed of a digital controlled precision mill, an accurate electro-hydraulic screwdown control, contact and radiation thickness gages, a general purpose computer, a teletype digital readout, and a two-channel strip recorder. Foils of Mo, V, Ta, Zr, and other metals alloys can be produced using the system. (J.R.D.)

2925 TECHNIQUE FOR PREPARING THE CROSS-SECTION OF PROTON-IRRADIATED 316 STAINLESS STEEL FOILS FOR TRANSMISSION ELECTRON MICROSCOPY. Spurling, R. A.; Rhodes, C. G. (North American Rockwell Science Center, Thousand Oaks, Calif.). Contract AT(04-3)-701. J. Nucl. Mater.; 44: No. 3, 341-4(Sep 1972).

A process for increasing the cross sectional area of a transmission electron microscopy thin foil by electroplating a 0.15 cm layer of nickel onto the sample is described. (T.F.D.)

2926 INTERNATIONAL CONFERENCE ON THE SCIENCE AND TECHNOLOGY OF IRON AND STEEL, TOKYO, JAPAN, SEPTEMBER 7–11, 1970. PART I. Conference Preprints. Tokyo; Iron and Steel Institute of Japan (1970). 365p. Y 14,000. (CONF-700923-(Pt.1)).

One-hundred-fifty-seven papers are included; a separate abstract was prepared for each of three. The remaining 154 papers contain information on: role of iron and steel industry in the social development of 70's; economic survival of the blast furnace; some structure-property relationships in Fe and steel; reflections on collective or cooperative research; ironmaking; steelmaking; physical chemistry of iron- and steelmaking; educational problems in metallurgy; and additional sessions on economics and management and "Tatara" ironmaking process. (P.C.H.)

For abstracts of individual papers see: 2927, 2928, and 2959.

2927 IRONMAKING WITH THE AID OF NUCLEAR ENERGY. Wenzel, W. (Technical Univ., Aachen). pp 106-9 of International Conference on the Science and Technology of Iron and Steel, Pt. I. Tokyo; Iron and Steel Inst. of Japan (1970).

From International conference on the science and technology of iron and steel; Tokyo, Japan (7 Sep 1970). See CONF-700923-(Pt.1).

It is speculated that nuclear energy could be applied to iron-making either as electrical energy or directly as heat energy. The simplest application seems to be the production of reducing gases from fossilized fuels. The most effective application of nuclear energy blast furnace practice is the exhausting of reducing gases produced by nuclear heat into the stack. Projects involving cheap atomic power could be realized soon; those involving nuclear heat could be developed within the next decade. (P.C.H.)

2928 MANUFACTURE OF 400 TON INGOT FOR ROTOR SHAFT OF NUCLEAR POWER PLANT. Morikawa, H.; Nakagawa, Y.; Maeda, K. (Japan Steel Works, Ltd., Muroran). pp 172-5 of International Conference on the Science and Technology of Iron and Steel. Pt. I. Tokyo; Iron and Steel Inst. of Japan (1970).

From International conference on the science and technology of iron and steel; Tokyo, Japan (7 Sep 1970). See CONF-700923-(Pt.1).

In 1969, the Japan Steel Works, Ltd. started the production of vacuum degassed 400 ton ingots for rotor shafts of nuclear power plants. Finished weight of these ingots will be about 200 tons. Some problems in the manufacture and quality of steel ingots are described. The results indicated that the decarburization equation may be inadequate over the latter stages of a heat and should possibly be modified to incorporate the effects of the secondary reactions of carbon to CO_2. In the latter stages, adapting the model to regard the diffusion of carbon as rate-determining factor governing decarburization has proved to be successful in achieving accurate predictions. The representation of P removal was very good. Manganese removal was adequately characterized, but could probably be improved with more accurate physical chemical data. The simulation of the oxygen system was not particularly good, especially with respect to the state of iron oxidation in the slag. (P.C.H.)

2929 DIFFUSION BONDED COLUMBIUM PANELS FOR THE SHUTTLE HEAT SHIELD. Korb, L. J.; Beuyukian, C. S.; Rowe, J. SAMPE Quart.; 3: No. 4, 1-11(Jul 1972).

Several different processes have been considered for joining metallic radiative heat shield panels for shuttle orbiter, including brazing, inert gas welding, electron beam welding, and diffusion bonding. Each method of joining has its distinct advantages and limitations. Diffusion bonding, however, has some unique advantages which make it quite attractive in certain types of designs. In this process, thick sections can be joined to thin sections without shrinkage or distortion. High strength joints are attained which are capable of 2500°F service. Diffusion bonded niobium parts readily accept current oxidative protective coatings without difficulties. Ultrasonic inspection is sufficiently developed to provide acceptance criteria for the majority of the joined areas. A review of the efforts at North American Rockwell in the design of niobium shuttle orbiter heat shield panels and in the development of a satisfactory method of diffusion bonding these panels is presented. (auth)

2930 WELDING AND BRAZING OF ADVANCED REFRACTORY ALLOYS. Slaughter, G. M.; Canonico, D. A.; Donnelly, R. G. (Oak Ridge National Lab., Tenn.). SAMPE Quart.; 9: No. 4, 17-20(Jul 1972).

The weldability of commercial refractory alloy sheet materials is compared for manual and automatic tungsten-arc and electron-beam processes. Brazing alloys are also described for joining graphite, refractory metals, and refractory oxides for high-temperature service without pretreatment. (auth)

2931 EXPERIMENTAL DETERMINATION OF PERMANENT ELASTIC–PLASTIC STRAINS IN BUTT JOINTS IN A ZIRCONIUM ALLOY CONTAINING NIOBIUM. Steklov, O. I.; Luchkin, R. S. (Technical Coll., Moscow). Automat. Weld. (USSR) (Engl. Transl.); 25: No. 2, 26-8(Feb 1972).

Translated from Avtomat, Svarka; 25: No. 2, 29-31(Feb 1972).

The residual welding stresses and plastic strains, and their distribution, in butt joints between plates and pipes of a zirconium alloy containing 2.5% Nb, made by electron-beam welding, were determined. (T.F.D.)

2932 COMBINED ELECTROLYTIC NICKEL–BORON COATINGS. Fedorchenko, I. M.; Guslienko, Yu. A.; Epik, A. P. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 31-4(Aug 1972). (In Russian).

The possibility of obtaining combined electrolytic coatings of nickel–boron with uniform distribution of boron particles over the matrix volume is discussed. Thermal diffusion annealing of such coatings led to the formation of qualitatively new structures and an increase in physical and mechanical properties of coatings. (auth)

2933 IRON-BASE CERAMIC ALLOY OF V2Zh TYPE. Antsiferov, V. N.; Bobrova, S. N. (Perm Polytechnic Inst., USSR). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 21-4(Aug 1972). (In Russian).

The results of research aimed at obtaining a wear-resistant alloy of the V2Zh type by powder metallurgy methods are described. The alloy obtained possesses a uniform fine-granular structure with high microhardness of structural components, strength equal to that of stellites, and, as distinct from the cast alloys of the similar type, good ability to be treated by cutting after softening thermal treatment. Optimal conditions for charge preparation, pressing, sintering, and conditions of thermal treatment are given. (auth)

2934 ELECTROLYTIC METHOD FOR PREPARING IRON–NICKEL–MOLYBDENUM ALLOY IN POWDER FORM. Golubkov, L. A.; Yur'ev, B. P. (Leningrad Polytechnic Inst.). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 1-7(Aug 1972). (In Russian).

An electrolytic method is described for obtaining three-component Fe–Ni–Mo powder-alloy with various compositions. An electrolyte that is rather stable in operation and with no organic complexing agents was used. This permits electrolysis to be realized by applying some soluble anodes and an insoluble anode with separate control of currents running through them. The effects of electrolysis conditions (D_k, temperature, pH, solution composition) were investigated as applied to cathode current efficiency, chemical composition, and alloy structure. It was established that under definite conditions of electrolysis, when the electric deposition of all the metals proceeds under diffusion kinetics regime, the composition of the obtained alloy depends only on the solution composition. Optimal conditions of electrolysis were worked out to obtain powder-alloy of permalloy composition. (auth)

2935 ORIENTATION-SENSITIVE COLOR-ETCHING TECHNIQUE FOR POLYCRYSTALLINE TUNGSTEN. Lehwald, S.; Erley, W.; Wagner, H. (Kernforschungsanlage, Juelich, Ger.). Prakt. Metallog.; 9: No. 9, 510-15(Sep 1972). (In German and English).

A color etching technique was developed for tungsten. The method offers a simple and rapid method of assessing the distribution of surface orientations on a W-specimen. The various low-indexed crystallite surfaces can be identified by different interference colors. In addition combinations of tungsten with other refractory metals can be studied metallographically in high contrast using the color etching technique. (auth)

2936 MICRO-MACHINING OF Nb_3Sn FOR INTRINSIC STABILIZATION. Bergmann, W. H.; von Grothe, K. H.; Scheffels, W. (Steigerwald Strahltechnik GmbH, Munich). pp 1126-35 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

The subdivision of Nb_3Sn deposits on commercial superconductors into small filaments of appropriate dimension for intrinsic stabilization is discussed. The technique employed for cutting the deposit is sublimation vaporization by the electron beam technology developed at Steigerwald Strahltechnik. This technique is described and the experimental results are discussed. (auth)

2937 METHODS AND APPARATUS FOR JOINING TUBES. Davies, David Charles; Greenhalgh, Frank Geoffrey (to United Kingdom Atomic Energy Authority). British Patent 1,285,036. 9 Aug 1972. Filed 13 Dec 1968.

Reference is made to methods and apparatus for end joining for alloy and steel tubes in a fluid-tight manner, with particular reference to the fabrication of pressure tubes for nuclear reactors. The method described comprises forming internal annular grooves or serrations at one end of the steel tube, inserting an end of the Zr alloy tube into this end of the steel tube, placing a loosely fitting support collar around this end of the steel tube, and internally roll swaging the overlapped portions of the tubes so as to deform the Zr alloy tube into engagement with the steel tube and its grooves, sufficient clearance being provided between the steel tube and support collar that the steel tube is elastically strained into support contact with the collar by the radially outward force exerted through swaging rollers. A heating step may be omitted if the support collar is sufficiently massive to resist deformation by the roll swaging loads and regard is paid to the clearance between the steel tube and support collar; also that the yield strength of the Zr alloy is sufficiently low at ambient temperature to enable satisfactory deformation. It is preferable that the support collar can be dismantled to facilitate removal from the joined tubes. (UK)

2938 METHODS AND APPARATUS FOR JOINING TUBES. Greenhalgh, Frank Geoffrey (to United Kingdom Atomic Energy

Authority). British Patent 1,285,037. 9 Aug 1972. Filed 13 Dec 1968.

Reference is made to methods and apparatus for end joining Zr alloy and steel tubes in a fluid-tight manner, with particular reference to the fabrication of nuclear reactor pressure tubes. A support collar is described for use in joining the tubes by a roll swaging technique, comprising an inner annular member formed of a number of segmental parts and an outer block in two parts for clamping the segments together. A heating step may be omitted where the support collar is sufficiently massive to resist deformation by the roll swaging loads and adequate regard is paid to the clearance between table and support collar; also that the yield strength of a Zr alloy is sufficiently low at ambient temperature to enable satisfactory deformation. The support collar described can be readily dismantled and removed from the joined ends to avoid the need for passing a long pressure tube through it. (UK)

2939 USE OF VACUUM BRAZING IN THE CONSTRUCTION OF RESEARCH EQUIPMENT. Gervais, R.; Georges, J. L.; Gillet, R. (CEN, Grenoble, France). Vide; 27: No. 158, 96-100 (Mar 1972). (In French).

The Mechanical Engineering Department of the Grenoble Nuclear Research Center is concerned with the research and development of equipment used in research. The working specifications led to the development of modern material joining techniques. Vacuum brazing techniques have been used since 1966. Their applications include: irradiation loops or rigs; cryostats, connecting boxes for vacuum engineering; x-ray windows. The difficulties encountered involve erosion of base materials by the brazing filler metal and the nonwetting of stainless steel when attempting to braze it to copper. The methods used to obtain good joints are discussed. (France)

Properties, Structure, and Phase Studies

Refer also to abstracts 2895, 3967, 4346, 4351, 4359, and 4424.

2940 (ORNL-4816) HEAVY-SECTION STEEL TECHNOLOGY PROGRAM. Semiannual Progress Report for Period Ending February 29, 1972. (Oak Ridge National Lab., Tenn.). Oct 1972. Contract W-7405-eng-26. 107p. Dep. NTIS.

The Heavy-Section Steel Technology (HSST) Program is one of the major USAEC-sponsored efforts concerned with the primary vessels for civilian water-reactor power plants. The main emphasis of the program is on the effects of flaws, material inhomogeneities, and discontinuities on the behavior of the vessels under normal operating and accident conditions. The program is coordinated with efforts by the manufacturing and utility sectors of the nuclear power industry to assess the in-service structural safety of the massive pressure vessels typical of those used in boiling- and pressurized-water reactor systems. Particular emphasis is placed on developing a technology that can be used to establish the margin of safety against failure of the vessels, particularly catastrophic failure beyond the control of plant safety features. There are 12 tasks of the HSST program. The activities of these tasks are grouped under administration and procurement, investigations of unirradiated materials, investigations of irradiated materials, and pressure vessel and piping investigations. There are 9 active research and development subcontracts sponsored by the HSST program. Results from these efforts as well as those performed at ORNL are extensively reported in technical reports and publications. Variability studies continued in which various mechanical property data, yield strengths, ultimate strength, and elongation and reduction-in-area values are compared as a function of plate section, plate location, depth location, and orientation. Charpy V-notch impact data are also compared as functions of position and orientation. (J.R.D.)

2941 (SC-DC-721415-A) TESTING OF URANIUM ALLOYS UNDER CONDITIONS OF RAPID FISSION HEATING. Reuscher, J. A. (Sandia Labs., Albuquerque, N. Mex.). [nd]. 4p. (CONF-721109-8). Dep. NTIS.

From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

A technique is described for measuring temperature-dependent thermomechanical properties of enriched μ alloys using the Sandia Pulsed Reactor. The reactor provides pulses at 40 to 100 μs of neutrons which induce rapid fission heating in rod-shaped specimens. (J.R.D.)

2942 (Y-DK-88) ANALYTICAL APPLICATIONS OF THERMAL METHODS OF ANALYSIS. Creech, E. T.; Richards, H. L.; Steckel, L. M.; Hamilton, J. H. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 27 Sep 1972. Contract W-7405-eng-26. 12p. (CONF-721025-1). Dep. NTIS.

From 16th conference on analytical chemistry in nuclear technology; Gatlinburg, TN. (24 Oct 1972).

Thermal analytical capabilities at the Y-12 plant are outlined. Examples are given on the application of thermogravimetric, evolved gas, and differential thermal analyses. (J.R.D.)

2943 EFFECT OF WELDING PARAMETERS ON THE SIZE OF WELD BEAD OF ZIRCONIUM ON GRAPHITE. Kravetsky, G. A.; Samosudov, V. V.; Dergunova, V. S. Svar. Proizv.; No. 3, 31-3(1971). (In Russian).

The effects of the welding-wire diameter, build-up rate, and current, on the size of built-up Zr bead on graphite with fusible (Zr) and/or nonfusible (W) electrodes, were investigated. A unit developed for building up Zr on graphite components with diameter of 30 to 150 mm and lengths up to 300 mm, is described. The use of W electrodes gave better results. Zr electrodes are recommended for graphite components with internal diameter <80 mm. (Metals Abstr.)

2944 EFFECT OF ALLOYING ON GAMMA AND GAMMA PRIME IN NICKEL-BASE SUPERALLOYS. Dreshfield, Robert Lewis. Cleveland; Case Western Reserve Univ. (1972). 134p. University Microfilms Order No. 72-26,150.

Thesis.

An investigation was conducted in which 11 Ni-base alloys were melted and heat treated for 4 hours at 1190°C followed by 1008 hours at 850°C. The alloys had the following composition ranges; Al 4.0 to 13 atomic %, Cr 6.5 to 20.5%, Ti 0.25 to 4.75%, Mo 0.0 to 6.0%, and W 0.0 to 4.0%. Electrolytic extractions were performed on the aged alloys using HCl in methanol and ammonium sulfate and citric acid in water as electrolytes. The residues from the ammonium sulfate electrolytic extraction for the two phase alloys were analyzed chemically and by x-ray diffraction. The results of the experimental determination of composition indicated that γ' varied from 72.1 to 78 atomic % Ni, 7.8 to 17.5% Al, 1.5 to 8.9% Cr, 0.3 to 13.9% Ti, 0.0 to 3.9% Mo, and 0.0 to 7.2% W. The composition of γ varied from 1.9 to 15.4 atomic % Al, 6.6 to 30.7% Cr, 0.0 to 3.1% Ti, 0.0 to 8.7% Mo, and 0.0 to 5.0% W. The γ and γ' hypersurfaces were fitted with an equation of the 3rd degree. A computer program was written which can calculate the composition of the conjugate γ and γ' from the composition of a two phase alloy. The program first finds the direction numbers of a tie line from the composition of the alloy, then locates the intersection of the tie line and the solvus hypersurfaces. The results of this calculation compared well with the experimental results and for at least one phase from 15 commercial Ni-base superalloys. The lattice parameters of γ and γ' were correlated to the phase compositions through simple linear equations. The γ' lattice parameters from commercial Ni-base superalloys were similarly correlated with the γ' composition. Phases other than γ and γ' were identified in some of the experimental compositions. The phases identified were sigma, mu, Cr solid solution, and Mo–W solid solution. The occurrence of these phases was related to the amount of Ni in the alloy, the quantity Cr + 1.75 (Mo + W) in the γ, and the change in Al relative to the change in Cr along the γ–γ' tie line. These same parameters appeared to be capable of being adapted for use with commercial Ni-base superalloys. (Diss. Abstr. Int., B)

2945 GRAIN BOUNDARY MIGRATION AND MORPHOLOGY ON VACUUM ANNEALED SURFACES OF HIGH-PURITY NIOBIUM (COLUMBIUM). Fritzke, G. P. (Stanford Linear Accelerator Center, Calif.). pp 117-25 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

The examination of the as-annealed surfaces of high-purity niobium under a light microscope reveals several instances of a step-wise, nonuniform, movement of grain boundaries. High temperatures (2100 to 2500°K), high vacuums (10^{-8} torr) and relatively long times (8 to 10 h) cause a small thermally etched surface to remain where a grain boundary resides for a short time and this provides a graphic and permanent picture of the grain boundary movement. There are also instances where surface impurities cause pinning of grain boundaries and thus provide a relatively large scale picture of phenomena that are usually considered to occur only on an atomic scale. Microphotographs are included and described which illustrate features formed before, during, and after recrystallization of the Nb samples. (J.R.D.)

2946 MICROSTRUCTURE OF EXTRUDED Ti-6Al-4V ALLOY BARS. Indap, R.; De Angelis, R. J. (Univ. of Kentucky, Lexington). pp 187-211 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

Microstructures of billets extruded at 1600, 1750, 1800, 1900, and 2150°F with two extrusion ratios-7:1, 10:1 were studied using optical and transmission electron microscopy. Duplicate billets were extruded for each condition; one being air cooled and the other directly water quenched from the press. Extruded bars processed from all temperatures show a variation in structure as a function of radial position. This effect is very pronounced in the 1750°F processed bars. Water quenched billets extruded below 1750°F show recovered structure with distinct sub-grain formation. Water quenched billets extruded above 1800°F show transformed beta with prior beta grain boundaries. These prior beta grains near the surface of billet are smaller compared to the grains at the center. Air cooled billets, extruded below 1750°F show higher amount of recovery but not complete recrystallization. Air cooled billets extruded above 1800°F show acicular alpha grown in the prior beta grains whose grain boundaries are visible. (auth)

2947 PHASE ANALYSIS OF A Pu–15 WT. PERCENT URANIUM ALLOY. Riefenberg, D. H.; Harvey, M. R.; Tennant, D. E.; Doyle, J. H. (Dow Chemical Co., Golden, Colo.). pp 265-71 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

A plutonium-15 wt % uranium alloy subjected to different cooling rates has been examined. X-ray techniques identify the alloy as single-phase zeta. Results of metallographic and density analyses, however, indicate the possibility of a multiphase system. Electron microanalysis proves the system is not single phase but multiphase containing zeta. (auth)

2948 METALLOGRAPHY OF MULBERRY. Romero, H. (Sandia Labs, Albuquerque, N. Mex.). pp 275-81 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

The metallography of Mulberry was studied in this investigation to show the microstructural differences between two heats of material. The metallography shows a significant variation in the content of small unidentified "freckle" inclusions between the two heats of Mulberry. No other differences were observed. (auth)

2949 ADSORPTION-INDUCED EMBRITTLEMENT OF METALS. Preece, Carolyn M. (State Univ. of New York, Stony Brook). Res./Develop.; 23: No. 10, 30-4(Oct 1972).

An explanation of the phenomena of liquid metal embrittlement and some guidelines for evaluating and avoiding the problem are discussed. Evidence is given that embrittlement results from a change in the relative values of the stresses for fracture and for flow. It is emphasized that the two greatest problems associated with liquid metal embrittlement are: lack of awareness of its existence and the lack of any consistent pattern of embrittlement couples. An example of an exception to any of the rules is the case of Ag–Hg and Ag–In, which have similar diagrams. However, the fracture stress of Ag is reduced by some 50% by Hg, but the embrittlement is inhibited by addition of In to the liquid. (P.C.H.)

2950 PHASE SEPARATION PROCESSES IN THE BETA PHASE OF Ti–Mo BINARY ALLOYS. Chandrasekaran, V.; Taggart, R.; Polonis, D. H. (Univ. of Washington, Seattle). Metallography; 5: No. 5, 393-8(Oct 1972).

Electron microscopy studies confirmed the occurrence of a phase separation reaction in a Ti–20 wt % Mo binary alloy as the result of aging at 450°C for times up to 15 mins. This observation is in agreement with predictions made on the basis of thermodynamic data. (auth)

2951 THERMAL ETCHING OF β Ti–V ALLOYS. Ling, Fu-wen; Starke, E. A. Jr. (Georgia Inst. of Tech., Atlanta). Metallography; 5: No. 5, 399-407(Oct 1972).

The thermal etching of β-Ti–V alloys by annealing in vacuum at 900°C is described. The thermal-etch pits and facets were correlated with dislocations. Using crystals of known orientation it has been determined that the facets consist of either {100}, {110}, or {112} planes and that the morphology of the pits depends on the surface orientation. (auth)

2952 ANALYTICAL-PRESHADOWED EXTRACTION REPLICA TECHNIQUE. Seher, Robert J.; Maniar, Gunvant N. (Carpenter Tech. Corp., Reading, Pa.). Metallography; 5: No. 5, 409-14(Oct 1972).

Submicroscopic particles in precipitation hardening superalloys were studied using extraction replica electron microscopy. Equations developed by McCall and Boyd to evaluate precipitate size, volume fraction, and interparticle spacing from extraction replica electron micrography were recently modified by Abrams to more accurately determine the volume of material from which the precipitate particles are extracted. The application of Abrams' modification to the study of gamma-prime precipitate in superalloys is reviewed. The analytical approach of Abrams was found to be unsuited to superalloys which contain a large volume fraction precipitate of uniform size. (auth)

2953 NITROGEN THERMOCHEMISTRY DURING THE COMBUSTION OF ZIRCONIUM DROPLETS IN N_2/O_2 MIXTURES. Meyer, R. T.; Breiland, W. G. (Sandia Labs., Albuquerque, N. Mex.). High Temp. Sci.; 4: No. 4, 255-71(Aug 1972).

Recent experiments have yielded new information pertinent to the physiochemical mechanism of microbubble formation and explosion of liquid zirconium droplets which are burned in N_2/O_2 mixtures at 3000 to 4000°K. Extensive application of a mass spectrometry technique for picomole gas analyses has provided N_2 evolution data as a function of reaction time, N_2/O_2 reactant ratio, and degree of prenitridation. Studies of the physical structure and internal color of the solidified reaction product as a function of N_2/O_2 and of reaction time have revealed the transitional progression of the reaction from slow oxidation to explosive combustion and the existence of concentration gradients within the reacting zirconium droplet prior to bubble formation. Detection of $^{29}N_2$ in droplets has suggested the possible role of atomic nitrogen in the bubble nucleation or growth processes. The results were combined with published data on the time dependence of surface temperature and color of burning zirconium droplets and the kinetics of oxidation to suggest a thermochemical mechanism for the explosion. The proposed mechanism is a self-accelerating, thermal decomposition of a metastable oxynitride of zirconium, in which the recombination of unstable nitrogen species provides a localized source of energy for the propagation of the reaction and the growth of a gas bubble to the explosion stage. The creation of the metastable composition is believed to result from the diffusion of nitrogen to the center of the droplet, which is induced by an oxygen concentration gradient and an associated gradient for the chemical potential of nitrogen. (auth)

2954 DETERMINATION OF LIQUIDUS CURVES FOR THE Th–W, Th–Ta, Zr–W, and Hf-W SYSTEMS: THE ANOMALOUS BEHAVIOR OF METALLIC THORIUM. Ackermann, R. J.; Rauh, E. G. (Argonne National Lab., Ill.). High Temp. Sci.; 4: No. 4, 272-82(Aug 1972).

Melting points, eutectic temperatures, and solubilities for the Zr–W, Hf–W, Th–W, Th–Ta, and other refractory metal systems have been measured by means of new and more precise modifications of existing methods. Only a few hundred milligrams of sample are required. Although the chemical behavior of thorium in the +4 valence state appeared to be an extension of the group IV elements, the results demonstrated an anomalous behavior of metallic thorium compared with zirconium and hafnium. This behavior was correlated with heats of vaporization, melting points, and solubility parameters. The Th–W system formed no intermetallic compounds but one was indicated in the Th–Ta system from the shape of the liquidus curve. The methods were applied to the determination of the liquidus-solidus curves in the U–Th–W system. (auth)

2955 POSSIBILITY OF O/U RATIO DETERMINATION IN UO_{2+x} POWDER SAMPLES BY NEUTRON DIFFRACTION. Ligenza, S.; Murasik, A.; Leciejewicz, J.; Solnicka, K. (Inst. of Nuclear Research, Swierk, Poland). J. Nucl. Mater.; 44: No. 3, 345-6(Sep 1972).

It has been established that UO_{2+x} (where x has any value between 0 and 0.25) exists as a single phase at high temperatures of about 800°C. Samples quenched from high temperatures disproportionate into a mixture of two phases according to the formula: $UO_{2+x} \rightarrow (1-4x)UO_2 + xU_4O_9$. The U_4O_9 phase can be identified by neutron-diffraction since apart from the fundamental fluorite-type reflections which are contributed by both phases, very weak superlattice peaks due to ordering of interstitial oxygen in U_4O_9 are observed on neutron patterns. However, the low intensities of those peaks for powder samples make the estimation of x very unreliable. Results of O/U determination in UO_{2+x} powder samples by neutron diffraction are presented and also compared to other experimental results. (T.F.D.)

2956 ESTIMATING THE ADHESIVE STRENGTH BETWEEN FILAMENT AND MATRIX IN REINFORCED METALS. Umansky, E. S. Probl. Prochnosti; No. 3, 31-4(Mar 1972). (In Russian).

The general principles underlying the production of a reinforced metal comprising a soft matrix and hard filaments by hot pressing are outlined with special attention to the question of the adhesion between the two constituent parts of the composite. A mechanical testing method for determining the adhesive strength is proposed. Examples are given for C steel/Al and Ni/Mo composites at 900°C. The adhesion between filaments and matrix varies smoothly with temperature. For each temperature, however, there is a critical length of filament giving the best properties. (Metal Abstr.)

2957 TECHNICAL NOTE: EMISSARY DISLOCATIONS ASSOCIATED WITH (1122) TWINS IN ZIRCONIUM. Dickson, J. I. (Univ. of Toronto); Dedo, A.; Craig, G. B. Can. Met. Quart.; 11: No. 3, 477-9(Sep 1972).

Experimental evidence is described for emissary dislocations obtained during a room-temperature study of $(11\bar{2}2)$ twinning in zirconium of approximately 99.9% purity, containing 100 to 200 (weight) ppM oxygen as the major interstitial impurity. (auth)

2958 EMISSION AND ADSORPTION CHARACTERISTICS OF A CESIUM FILM ON THE (110), (112), (100), AND (111) FACES OF A LARGE MOLYBDENUM MONOCRYSTAL. Azizov, U. V.; Karabaev, T. A. (Tashkent State Univ.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 2, 81-3(1972). (In Russian).

The emission and adsorption behavior of a Cs film on the basic faces of a polyspherical monocrystal of Mo was investigated under vacuum. Thermoemissive constants for faces (110), (112), (100), and (111) were determined by Richardson's method. A stream of Cs atoms were directed at the cleaned surface of the Mo crystal, and adsorption curves were determined for the same four faces at a flux of 10^{12} atoms/cm^2 · sec at temperatures ranging from 570 to 600°K. (K.S.W.)

2959 FORMATION OF INCLUSIONS IN LIQUID IRON BY COUNTER DIFFUSION OF REACTANTS: Zr AND O OR N. Arita, M.; Gunji, K. (National Research Inst. for Metals, Tokyo). pp 306-7 of International Conference on the Science and Technology of Iron and Steel. Pt. I. Tokyo; Iron and Steel Inst. of Japan (1970).

From International conference on the science and technology of iron and steel; Tokyo, Japan (7 Sep 1970). See CONF-700923-(Pt.1).

Since Zr is known as a deoxidizing element and has great bond strength with N in molten Fe, studies were made on the counter diffusion of Zr and O or N in molten iron. A pure Fe bar saturated with O and N or N only was melted in an alumina tube at 1600°C. After 15 min from addition of Fe–Zr alloy (5 or 20% Zr) onto the molten Fe, the tube was taken out and cooled in water. Samples were investigated by optical microscopy. In two samples, inclusions of yellow cubic zirconium nitride were formed continuously in the region beneath the boundary. In another sample, only very few inclusions of zirconium nitride existed beneath the boundary. To interpret the results, two equations of Fick's second law on the counter diffusion of Zr and N (or Zr and O) were solved by a computer using specific assumptions. (P.C.H.)

2960 INTERNATIONAL CONFERENCE ON THE SCIENCE AND TECHNOLOGY OF IRON AND STEEL, TOKYO, JAPAN, SEPTEMBER 7–11, 1970. PART II. Conference Preprints. Tokyo; Iron and Steel Institute of Japan (1970). 356p. Y 14,000. (CONF-700923-(Pt.2)).

One-hundred-fifty-eight papers are included; a separate abstract was prepared for each of four. The remaining 154 papers contain information on: rolling of iron and steel; sheet metal forming and formability; and physical metallurgy of iron and steel. (P.C.H.)

For abstracts of individual papers see: 2961–2964.

2961 EXPLANATION OF SOLUTION SOFTENING IN Fe–Mo ALLOYS. Sakuma, T.; Karashima, S. (Tohoku Univ., Sendai). pp 505-6 of International Conference on the Science and Technology of Iron and Steel. Pt. II. Tokyo; Iron and Steel Inst. of Japan (1970).

From International conference on the science and technology of iron and steel; Tokyo, Japan (7 Sep 1970). See CONF-700923-(Pt.2).

Studies on solution-softening in Fe-base–Mo alloys at a base strain rate of 4×10^{-5} sec^{-1} suggest that overcoming the stress fields of solute atoms is the rate-controlling mechanism in these substitutional alloys at low temperatures. (P.C.H.)

2962 MISCIBILITY GAP IN Fe–Cr–X (X: Cu,Mn,Mo,Ni,V,-Si,Al). Yamaguchi, M.; Umakoshi, Y.; Mima, G. (Osaka Univ.). pp 524-5 of International Conference on the Science and Technology of Iron and Steel. Pt. II. Tokyo; Iron and Steel Inst. of Japan (1970).

From International conference on the science and technology of iron and steel; Tokyo, Japan (7 Sep 1970). See CONF-700923-(Pt.2).

A constitutional investigation on the miscibility gap in ternary Fe–Cr–X systems was undertaken to understand clearly the effects of ternary alloy additions on the miscibility gap in the Fe–Cr system. In the differential thermal analysis of the aged alloy, an endothermic peak was observed around 600°C. This peak resulted from resolution of the precipitates that were formed due to the occurrence of the miscibility gap and therefore the peak temperature indicated roughly the boundary of the miscibility gap for the chemical composition of interest. The ternary tie-line and the 480°C isothermal section of the miscibility gap were determined by obtaining the constitution of the tie-line iron-rich solid solution which was roughly evaluated by means of the Moessbauer measurement of the alloy aged at 480°C. Characteristics of the shape of miscibility gap and tie-line obtained experimentally were considered to coincide qualitatively with those predicted theoretically. (P.C.H.)

2963 STUDY OF THE ISOTHERMAL PRECIPITATION OF VANADIUM NITRIDE IN SOME IRON ALLOYS. Lambert, N.; Crustin, J.; Greday, T. (CNRM, Liege). pp 538-9 of International Conference on the Science and Technology of Iron and Steel. Pt. II. Tokyo; Iron and Steel Inst. of Japan (1970).

From International conference on the science and technology of iron and steel; Tokyo, Japan (7 Sep 1970). See CONF-700923-(Pt.2).

The precipitation of vanadium nitride under isothermal conditions was studied in nearly carbon-free Fe–Mn–Si alloys at 500 to 1000°C. The results showed that the delay time for precipitation was very short (less than 2 min at 600°C). Precipitate densities were very strong and varied only between 10^{16} to 10^{17} particles/cm^3. The density decreased as the temperature of the isothermal treatment became higher. As far as the mechanical properties are concerned, it was concluded that: the higher level of the yield strength was obtained at 500 or 550°C; and the obtained level of yield strength was in the range 55 to 60 kg/mm^2, which can only be explained by a very strong precipitation hardening. From calculation of the theoretical yield strength, it was concluded that the precipitation contribution to the strengthening was of the order of 16 to 24 kg/mm^2. Thus, it seems possible to improve the mechanical properties of steel products (sheets, rods, etc. . . .) by a control of the precipitation process. (P.C.H.)

2964 STUDY ON ASTM A543 STEEL AS MATERIAL FOR THE CONSTRUCTION OF REACTOR PRESSURE VESSELS. ASTM A543 AND ITS WELDING MATERIALS. Sakakihara, M.; Yoshimura, H. (Nippon Steel Corp., Fukuoka). pp 570-1 of International Conference on the Science and Technology of Iron and Steel. Pt. II. Tokyo; Iron and Steel Inst. of Japan (1970).

From International conference on the science and technology of iron and steel; Tokyo, Japan (7 Sep 1970). See CONF-700923-(Pt.2).

Studies were made on the heat treatment characteristics of ASTM A543 steel that has a tensile strength of the 74 kg/mm^2 class, and also on various alloying elements of welding materials applicable to this type of steel in an attempt to develop an optimum welding material. Four grades of steel with different content levels of C and V were melted and rolled into 25 mm plates, which were subsequently examined for tensile properties following heat treatments and also for their welded joint performance under submerged-arc welding. The characteristics of all plates after stress-relief annealing indicated that the greater the cooling rate during quenching, the better, and the optimum tempering temperature was found to be 650°C. In regard to characteristics of weld metal after submerged-arc welding and stress relief annealing, increased Ni content of the welding material was found to improve both the strength and toughness of the former, whereas increased Cr content of the welding material was found not to change the strength but rather to deteriorate the toughness of the weld metal. Cu additions improved strength and toughness somewhat. (P.C.H.)

2965 LOSSES OF DIFFERENT WCu SINTERED IMPREGNABLE MATERIALS IN AIR AT HIGH CURRENTS. Haufe, W.; Reichel, W.; Schreiner, H. (Siemens AG, Munich). Z. Metallk.; 63: No. 10, 651-4(Oct 1972). (In German).

The losses of WCu sintered impregnable materials containing 43 to 87 wt % W during high-current testing were determined. Electrolytic Cu and sintered WNi were measured for comparison. The current was I_{max} = 90 kA (f = 3 kHz). The specific losses of the WCu sintered impregnable materials in air have a flat minimum at 60 to 70 wt % W. If compared with measurements in oil an essential difference is found for electrolytic Cu. The average of the specific loss of electrolytic Cu in oil is about 4 times as high as in air because of streaming influences of the oil and its decomposition products. The losses of the WCu sintered impregnable materials are within the same scatter independent of the environment. Apart from the specific losses, the hardness and the electrical conductivity were measured which showed a pronounced concentration dependence. (auth)

2966 INVESTIGATION OF THE COMPLEX OF THERMAL PROPERTIES OF LIQUID METALS AT HIGH TEMPERATURES. Atalla, S. R.; Banchila, S. N.; Filippov, L. P. (Moscow State Univ.). High Temp. (USSR) (Engl. Transl.); 10: No. 1, 60-3 (1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 72-6(1972).

An improved unit is described for measuring the thermal diffusivity and the heat capacity of liquid metals in the temperature range from 1100 to 2100°K; the unit is based on application of the method of radial temperature waves, with variable cyclic heating of the sample by electron bombardment. The results of an investigation of liquid indium, neodymium, and cerium are given. (auth)

2967 THERMAL PROPERTIES OF TANTALUM–TUNGSTEN ALLOYS AT HIGH TEMPERATURES. Arutyunov, A. V.; Banchila, S. N. (Kaliningrad Technical Inst. of Fishery and Fish Breeding, USSR). High Temp. (USSR) (Engl. Transl.); 10: No. 1, 166-8(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 190-2(1972).

The properties of three substitutional alloys Ta-12W, Ta-15W, Ta-22W, and of one interstitial alloy Ta-17 W-0.25 C were investigated. The effect of tungsten concentration and structure on the thermal and electrical properties of alloys in the temperature range 1000 to 2500°K was studied. The results are presented graphically. (M.O.W.)

2968 IMPACTS ON STEEL AND GRAPHITE. McCalvey, L. F. (International Research and Development Co. Ltd., Newcastle-upon-Tyne, Eng.). Strain; 8: No. 4, 177-9(Oct 1972).

Although it has been accepted for some time that the damage criterion for impact of falling objects is the velocity at impact, there has been little acceptance of the view that velocity at impact determines damage in radial impacts such as occur in charge/discharge of fuel elements or gas-induced vibrations in pins in elements. Most A.G.R. tests to data have been based upon interpretation of results from accelerometers to establish acceleration or deceleration values at impact. It is suggested that this practice is misleading. Variation in material properties due to temperature changes affect the stresses set up by impact. This effect is considered in relation to graphite and stainless steel. (auth)

2969 SUPERPLASTICITY AND HIGH-TEMPERATURE STRENGTH IN METAL SYSTEMS. Kornilov, I. I. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 200: No. 4, 835-8(1 Oct 1972). (In Russian).

A comparison was made between thermal stability and plasticity of alloys in simple and multicomponent metal systems at high temperatures (400 to 1000°C). This comparison included such systems as Ni–Cr, Ti–Cu, Ti–V–Nb, and Ni–Cr–W–Ti–Al, for which data on load-bending over periods of time from 60 to 1500 hr were available. In systems with limited solubility of components, thermal stability and superplasticity were possessed by certain alloys under a specially defined use of the term superplasticity. The data showed that the time of attainment of a prescribed load-induced deflection of sagging differed by several units in some cases to thousands in other cases. (K.S.W.)

2970 THERMOPHYSICAL PROPERTIES OF ARC-CAST TUNGSTEN USING THE TPRC MULTI-PROPERTY APPARATUS (DIRECT HEATING METHOD). Taylor, R. E. (Thermophysical Properties Research Center, Lafayette, Ind.). High Temp. - High Pressures; 4: No. 1, 59-66(1972).

The thermophysical properties of a sample cut from a bar of arc-cast tungsten were measured to 2800°K. Samples from this bar have been sent for physical property measurements to a number of laboratories throughout the North Atlantic Treaty Organization countries as part of an AGARD (Advisory Group for Aerospace Research and Development) program. The results from the various laboratories will be compared and analyzed. The thermophysical properties measured at TPRC at this time include normal spectral emittance, hemispherical total emittance, electrical resistivity, thermal conductivity, and Lorenz function. The multi-property apparatus previously described (Taylor, Davis, and Powell, 1969; Powell and Taylor, 1970) was used for these measurements. The method involves heating the sample to high temperatures by passing a large electrical current through it. Emittances and electrical resistivities are determined under isothermal conditions and the thermal conductivity is determined from temperature profiles. (auth)

2971 SINTERED STEEL X13 FOR FUEL ELEMENT CLADDING FOR FAST NEUTRON REACTORS. I. STEELS NOT CONTAINING TiO_2. Denisenko, E. T.; Van Asbroec, Ph. (Inst. of Problems in Material Studies, Kiev). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 89-102(Aug 1972). (In Russian).

The structure, stability, and creep of a ferrite sintered steel containing a nominal 13% Cr were studied relative to their dependence on various metallurgical factors, which are connected with the use of sintered steel as fuel element cladding in fast reactors. The effects of small additions of Mo, W, and TiO_2 and of forging both at room temperature and at higher temperatures were investigated. Carbide formation led to embrittlement of the steels; it is suggested that either the carbon content of the original metal be reduced, or that an additive which has an affinity for carbon be employed. (K.S.W.)

2972 METHOD FOR DIRECT OBSERVATION OF PORES IN POROUS MATERIALS. Golovkina, T. E.; Davydova, L. N.; Ignat'ev, N. A.; (and others) (All-Union Scientific-Research Inst. of Aviation Materials, Moscow). Porosh. Met., Akad. Nauk Ukr. SSR; No. 8, 77-80(Aug 1972). (In Russian).

A method is described for the direct observation of open pores in porous materials by means of pore filling with liquid substance with its subsequent solidification and by means of solution of the basic material. The results of investigations on porous samples of pressed and sintered tungsten and Nichrome powders are presented. It was found that the suggested method gives an idea on shape, size, and mutual arrangement of separate open pores. (auth)

2973 LATTICE DYNAMICS, THIRD ORDER ELASTIC CONSTANTS, AND THERMAL EXPANSION OF CADMIUM. Menon, C. S.; Rao, R. R. (Indian Inst. of Tech., Madras). J. Phys. Chem. Solids; 33: No. 11, 2129-39(Nov 1972).

The lattice dynamics, second and third order elastic constants, pressure derivatives of the second order elastic constants, and the temperature variation of the lattice thermal expansion of cadmium were worked out utilizing Keating's approach (Phys. Rev. 145, 637, 1966 and 149, 674, 1966). The ten TOE constants were calculated using four anharmonic parameters. The model used reproduced the measured pressure derivatives of the SOE constants of cadmium extremely well. The low temperature limit of the volume Gruneisen function γ_L was found to be nearer to the value of Andres (1964). The high temperature limit $\gamma_v(T)$ was in good agreement with the value calculated by Gschneidner Jr. (1964) from the Cv data for cadmium. The lattice dynamics of cadmium were found to be essentially similar to that of zinc. (auth)

2974 DIAGRAMMY SOSTOYANIYA METALLICHESKIKH SISTEM. (Phase Diagrams of Metallic Systems). Fourth All-Union Conference on Phase Diagrams, Moscow, June 3–6, 1969. Ageev, N. V.; Ivanov, O. S. (eds.). Moscow; Izdatel'stvo Nauka (1971). 272p. (CONF-690668).

A collection of 54 papers delivered at the 1969 conference has been grouped into six parts according to the subject matter. The first part is of especial interest to nuclear technology, since it contains phase composition diagrams involving U, Th, Nb, Mo, Zr, and Hf. Part II is concerned with refractory metals and contains phase composition diagrams of W, Ge, Mo, Nb, Ta, B, Ni, Al, Si, Hf and C, most diagrams being binary or ternary in scope. Parts III and IV deal with systems involving Ti or Cr and the iron group, respectively. Part V includes rare earth metals (Y, Nd, Pr, Ce, Ru, and Er, with some admixture of the precious metal Pt. Part VI focuses attention on methods of depicting phase diagrams and interpreting them in terms of thermodynamic data, metastable states, free energy surfaces, and energy characteristics. (K.S.W.)

2975 ARSENIC–MOLYBDENUM–TUNGSTEN HETEROPOLY-COMPLEX. Reznik, B. E.; Statsenko, V. P.; Tsyganok, L. P.; Shubina, L. V. (Dnepropetrovsk State Univ., USSR). Zh. Neorg. Khim.; 17: No. 10, 2752-5(Oct 1972). (In Russian).

The reduction of a AsMoW heteropolycomplex by ascorbic acid in a sulfuric acid medium resulted in the formation of a compound with the formula $AsMoW_{11}$ which had a light absorption at 500 nm. A potentiometric titration of $AsMoW_{11}$ was conducted with $TiCl_3$, revealing two discontinuities in the titration curve which are discussed. The initial oxidizing potential of $AsMoW_{11}$ in 0.12 N HCl was 0.560 mV. (K.S.W.)

2976 SELF-DIFFUSION OF THE bcc ϵ Pu UNDER HYDROSTATIC PRESSURE. Calais, D.; Cornet, J. A. (CEN, Fontenay-aux-Roses, France). Mem. Sci. Rev. Met.; 69: No. 6, 493(Jun 1972). (In French).

The hydrostatic pressure parameter was used to determine the self-diffusion activation volume of Pu in the epsilon phase (bcc). Couples having different ^{240}Pu contents were studied. The diffusion annealing was effected in a piston-cylinder type pressure chamber in a purified argon atmosphere. After treatment, the couples were roughened parallel to the adhesion interface and the activity of the faces for an energy of about 17 keV (uranium L conversion line) was compared using a scintillation detector and a 400 channel analyzer. The $(P)_T$ curves exhibit in the first approximation an exponential growth of the diffusion coefficient with P. This result, which is abnormal, may be explained by the low activation enthalpy characteristics of the diffusion in this phase. The activation volume is $AV = -5\ cm^3$. (France)

2977 EFFECT OF COOLING RATE ON THE STRUCTURE FORMATION IN IRON–TUNGSTEN AND IRON–MOLYBDENUM ALLOYS. **Polesya, A. F.; Slipchenko, L. S.; Burov, L. M.; Gudzenko, V. N.; Demeshkin, V. I. Izv. Vyssh. Ucheb. Zaved., Chern. Met.; No. 9, 114-17(1971). (In Russian).**

The effect of high cooling rates on the structures of Fe–W and Fe–Mo alloys was studied. For a cooling rate of 10^3°C/s no supersaturated solid solution with a concentration exceeding the maximum equilibrium solubility (13 for W and 26 at.% for Mo) was obtained. For a cooling rate of 10^5°C/s the range of solid solutions extended to 18.5 W and 32 at.% Mo, respectively. For a cooling rate of 10^7°C/s the corresponding figures were 20.8 and 40.6 at.%. For concentrations higher than these the intermetallic compounds Fe_7W_6 and Fe_7Mo_6 precipitated. (Metals Abstr.)

2978 BEHAVIOR OF CARBON IN SINGLE CRYSTALS OF MOLYBDENUM AND MOLYBDENUM–47 PERCENT RHENIUM. **Savitskii, E. M.; Nakonechnikov, A. I.; Burkhanov, G. S.; Tetyueva, T. V. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 200: No. 6, 1326-8(21 Oct 1971). (In Russian).**

The peculiarities in the arrangement of carbon in single crystals of Mo and of the alloy Mo + 47% Re were investigated by means of electron microscopy and autoradiography. The diffusion mobility of carbon in such crystals (and in pure Re) at 1200 to 1600°C was studied using ^{14}C as a tracer, and diffusion coefficients were calculated. In Mo single crystals the carbide Mo_2C was irregularly distributed both as regards the boundaries and also the subgrain region. (K.S.W.)

2979 PHASE DIAGRAM OF THE SYSTEM NEODYMIUM–YTTRIUM. **Svechnikov, V. N.; Kobzenko, G. F.; Martinchuk, E. L. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 8, 754-6(Aug 1972). (In Ukrainian).**

Cast and annealed (1000, 800, 600, and 450°C) alloys were studied by the methods of differential thermal, x-ray diffraction, metallographic, dilatometric, and durometric analyses. A complete phase diagram is plotted. Some electrophysical properties were investigated. The alloys are established to undergo in dependence on temperature and composition four non-variant transformations to which the following reactions correspond: $\beta_Y \rightleftharpoons L + \alpha_Y$, $L + \alpha_Y \rightleftharpoons \beta_{Nd}$, $\beta_{Nd} + \alpha_Y \rightleftharpoons \alpha_{Nd}$, and $\alpha_{Nd} + \alpha_Y \rightleftharpoons Nd_xY_y$. (auth)

2980 THERMALLY ACTIVATED DEFORMATION OF NIOBIUM–MOLYBDENUM AND NIOBIUM–RHENIUM ALLOY SINGLE CRYSTALS. **Statham, C. D.; Koss, D. A.; Christian, J. W. (Oxford Univ.). Phil. Mag.; 26: No. 5, 1089-1103(Nov 1972).**

Measurements of the yield-stress and of the strain-rate sensitivity in compression over the temperature range 14 to 373°K are reported for single crystals of niobium of two purities and for niobium alloy single crystals containing up to 25% molybdenum or 9% rhenium. As the solute content increases, the maximum in the curve of strain-rate sensitivity versus temperature first decreases in magnitude and then moves to higher temperatures, and in the more concentrated alloys a second peak appears at lower temperatures. A corresponding inflection appears in the curves of yield stress versus temperature, and a similar temperature dependence of the yield stress is also observed in ultra high vacuum annealed niobium. Analysis of the activation parameters indicates that there are two rate-controlling mechanisms in different ranges of temperature. These processes occur in a parallel manner in such a way that, at constant strain rate, the mechanism requiring lowest stress is selected. It is therefore suggested that the processes are similar in character but involve two separate saddle-point configurations which are affected by the additions of substitutional solute atoms. (auth)

2981 EFFECT OF HEAT-TREATING CONDITIONS ON DUCTILITY OF DOPED TUNGSTEN FILAMENTS. **Yamamoto, H.; Kamoshita, G.-I. (Hitachi Ltd., Tokyo). J. Jap. Inst. Metals; 36: No. 9, 875-80(Sep 1972). (In Japanese).**

The conditions of powder metallurgy and drawing processes which are required to develop the ductility of the filament were previously reported by the authors. In regard to the filaments developed, studies were made to determine the best heat-treatment conditions, including temperature, duration time, and heating rate, for a remarkable increase in filament ductility. The filaments which were secondarily recrystallized by heating at temperatures lower than 2200°C and for a duration longer than 15 min or at a heating rate lower than 36.3°C/s gained remarkable ductility, that is, the elongation of the coiled coil filament exhibited 600 to 800% which was several times greater than the elongation value of usual filaments. The contaminating effect of Ni or Fe coexisting with the filament under recrystallization on the filament ductility was examined too. It was found that Ni generally reduced the recrystallization temperature and ductility of the filaments. However, if Ni or Fe reacted with the secondarily recrystallized filament, these elements increased filament ductility. (auth)

2982 LAVES PHASES IN THE SYSTEMS $Zr\{Fe,Co,Ni\}_2$–$Zr\{Mo,W,Re\}_2$. **Pet'kov, V. V.; Kotsyuruba, A. V. (Inst. of Metal Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 8, 750-3(Aug 1972). (In Ukrainian).**

The Laves phases were investigated in the systems $Zr\{Fe,Co,Ni\}_2$–$Zr\{Mo,W,Re\}_2$. The systems $Zr\{Fe,Co\}_2$–$Zr\{Mo,W\}_2$ are characterized by formation of ternary λ_1-phases having a wide range of homogeneity along the isoconcentrate 33.3 at. % Zr. The ternary Laves phases are not formed in systems with nickel. The limited solid solutions on the base of binary compounds $ZrFe_2$, $ZrCo_2$, $ZrNi_2$ and $ZrRe_2$ are formed in the systems $Zr\{Fe,Co,Ni\}_2$–$ZrRe_2$. (auth)

2983 PHASE DIAGRAMS OF THE SYSTEMS PbTe–UTe AND SnTe–UTe UP TO 10 MOLE PERCENT UTe. **Terekhov, G. I.; Sinyakova, S. I.; Ivanov, O. S. (Inst. of Metallurgy, Moscow). Inorg. Mater. (USSR) (Engl. Transl.); 8: No. 4, 611-13(Apr 1972).**

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 8: No. 4, 701-3(Apr 1972).

A study of the microstructure of SnTe–UTe alloys quenched from 650°C revealed that up to 5.0 mole % UTe the alloys are solid solutions. With an increase of the UTe content to more than 6 mole % a second phase appears in the form of gray plates. A study of the microstructure of alloys quenched from 450°C did not reveal any change in solubility in comparison with the previous temperature. The solubility of UTe in SnTe in the range 400 to 775°C is ~6.5 mole % UTe. Alloys of PbTe–UTe quenched from 800°C with up to 5 mole %UTe were found to be solid solutions. A second phase as plates was observed in alloys with 6 mole % UTe. The microstructure of alloys quenched after annealing at 650° and 500°C did not reveal a marked change in the solubility of UTe in PbTe in comparison with 800°C. The solubility of UTe in PbTe in the range 400 to 900°C is ~5 mole % UTe. (T.F.D.)

2984 RAISING THE PHYSICO-MECHANICAL PROPERTIES OF NIOBIUM AND ITS ALLOYS BY NITRIDING. **Lakhtin, Yu. M.; Kogan, Ya. D.; Bobok, A. N. Vestn. Mashinostr.; No. 7, 65-7 (1971). (In Russian).**

Results are given from a study of the effect of nitriding on the hardness and creep resistance of a Nb–1% Zr alloy. Nitriding raises the hardness to an extent determined by the nitriding temperature, the maximum being reached at 1500°C in the core (340 kg/mm^2) and at 1300°C on the surface (2200 kg/mm^2). During nitriding there is a suppression of recrystallization in the surface zones of the components. Maximum increase in creep resistance is achieved by nitriding for 1 h at 1200°C. (Referativnyi Zh.)

Radiation Effects

Refer also to abstracts 3960, 4315, and 4775.

2985 (AECL–4252) ON BUBBLE STRENGTHENING OF ZIRCONIUM ALLOYS. **Schulson, E. M. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Sep 1972. 24p. Dep. NTIS (U. S. Sales Only). AECL $1.00.**

A theoretical analysis is presented which considers the strengthening of Zr alloys in creep through the interaction of mobile dislocations and gas bubbles. By introducing small amounts of the elements ^9Be, ^6Li or ^{10}B, He gas can be produced during neutron irradiation via the (n,α) transmutation reactions. The questions discussed in the report are: (1) Can He bubbles be produced during irradiation in a typical CANDU flux at temperatures between 300°C and 450°C?, (2) If so, what will be their expected size and number density?, and (3) What size and number density will probably be required to reduce the creep rate to $< 10^{-7}$/hr? The calculations indicate that bubbles could form, but that the amount of gas likely to be produced may not be large enough to impart the desired strengthening. (auth)

2986 (HEDL-SA–482) CALCULATION OF DISPLACEMENT RATES IN STAINLESS STEEL UNDER NEUTRON AND ELECTRON IRRADIATIONS. **Doran, D. G. (Hanford Engineering Development Lab., Richland, Wash.). Aug 1972. Contract AT(45-1)-2170. 34p. (CONF-721037-2). Dep. NTIS.**

From Specialists' meeting on radiation damage units for ferritic and austenitic stainless steels; Seattle, WA. (31 Oct 1972).

A review is presented on the development of calculation methods for metal atom displacements by neutrons and in high-voltage electron microscopes. Calculation procedures for stainless steel are discussed. It is suggested that a free-defect cross section estimated for neutron irradiation by taking 20% of the displace-

ment cross section calculated using $T_d \cong 40$ eV is reasonably consistent with a free-defect cross section of ~20 barns for electron irradiations (preferably in ⟨100⟩ or ⟨110⟩ directions). A Lindhard-based model, in conjunction with a full treatment of neutron scattering, should be used to compute the displacement cross section for neutron irradiations. (J.R.D.)

2987 (KFK-1640) FUNDAMENTALS OF RADIATION STRENGTHENING. Bocek, M. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Jul 1972. 66p. (In German). Dep. NTIS (U. S. Sales Only).

Some fundamental experimental results about the plasticity of neutron-irradiated metals at low temperatures are reported. The influence of irradiation on the flow stress as well as on its temperature dependence is the most interesting question. As shown, an understanding of these effects necessitates detailed knowledge of the kinds of interactions between irradiation defects and other intrinsic lattice defects which may contribute to the flow stress. Some ideas in this field are illustrated on the basis of simple models. (auth)

2988 (RD/B/N-2182) VOID SWELLING CHARACTERISTICS OF NIMONIC PE-16 ALLOY IN THE HIGH VOLTAGE ELECTRON MICROSCOPE. Williams, K. R.; Fisher, S. B. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Dec 1971. 28p. Dep. NTIS (U. S. Sales Only).

The swelling behavior of Nimonic PE-16 alloy was studied by high voltage electron microscopy. The rate of void swelling was found to be highly dependent on damage rate, temperature and γ' particle size. Significant swelling was only achieved at damage rates approaching 10^{-2} d/a/sec, and at specific-γ' particle sizes. At small (3 to 30 Å), and large particle diameters (>700 Å) the swelling rate was a maximum. In the fully aged condition with particle diameters of the order 200 Å, the swelling rate was minimized. The mechanism of void swelling has been attributed to the non-conservative climb of irradiation induced dislocations. (auth)

2989 INVESTIGATION OF CORROSION BY A METHOD OF NON-SIMULTANEOUS PROCESSES WHICH OCCUR ON THE SURFACE OF TWO ELECTRODES MADE OF THE MATERIAL OF INTEREST. Beran, Jaroslav. Jad. Energ.; 18: No. 10, 330-2 (Oct 1972). (In Czech).

A technique previously developed for observing corrosive attack on aluminum alloys in a reactor consisted of non-simultaneous processes on a corroding surface using electrodes made of the material under study. This technique was further developed for investigating intercrystalline corrosion and corrosion during stress of stainless steels and in probing the character of attack on Zr alloys under operating conditions of a reactor such as the VVER type. The possibility of utilizing automated apparatus for observing the character of corrosive attack more closely and the corrosion rate by means of the polarized resistance in conjunction with two independent electrodes is discussed. (tr-auth).

2990 NEUTRON INDUCED VOIDS IN NICKEL: THE LOW DOSE DEPENDENCE AT 400°C. Harbottle, J. E.; Dickerson, S. M. (Central Electricity Generating Board, Berkeley, Eng.). J. Nucl. Mater.; 44: No. 3, 313-17(Sep 1972).

The neutron fluence dependence of void growth in pure nickel has been studied by electron microscopy in the dose range 2×10^{17} to 1×10^{20} n/cm² (E > 1 MeV) at 400°C. The void concentration is linear with fluence above a critical fluence of 4×10^{17} n/cm², but the swelling obeys a decreasing power law, with rapid void growth occurring in the early stage following nucleation but then subsequently decreasing as nucleation continues. The initial growth stage is discussed in terms of either surface absorption or volume diffusion being the governing process, but although the results cannot definitely choose between them, it is argued that the kinetics of the void surface are more likely to control the growth rate of very small voids. The role of transmuted helium in the nucleation of voids cannot be ruled out, and if it is important then the helium concentration at the critical dose leads to an upper limit of ~50 helium atoms per void. (auth)

2991 STABILITY OF PRECIPITATES IN AN IRRADIATION ENVIRONMENT. Nelson, R. S.; Hudson, J. A.; Mazey, D. J. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater.; 44: No. 3, 318-30(Sep 1972).

When an alloy containing precipitates is irradiated, two processes occur which perturb the equilibrium conditions set solely by thermodynamics. First, the irradiation can enhance the solute diffusion within the host matrix; and second, the irradiation can destroy the precipitates. New equilibrium conditions are therefore set up which depend on the details of the irradiation environment. The basic physical processes which occur during the irradiation of an alloy containing precipitates are discussed in some detail, and approximate mathematical expressions derived. Experimental evidence is then discussed which substantiates the theoretical predictions. Finally, some implications are considered. (auth)

Other Materials

Refer also to abstracts 2471, 2477, 2504, 2663, 2372, 2878, 2897, 2930, 2968, 2975, 3074, 4323, and 4328.

2992 (CEA-CONF-2031) ELEMENTARY MODEL OF MACROSCOPIC EFFECTS OF NEUTRON IRRADIATION IN GRAPHITE. Genthon, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 22 Sep 1970. 14p. (In French). (CONF-700982-1). Dep. NTIS (U. S. Sales Only).

From 28th conference of the Dosimetry Group of EURATOM; Juelich, Germany (30 Sep 1970).

A model for graphite defects caused by neutron irradiation was studied and confirmed. The model assumes zones of displacement. It was found that these zones comprised approximately four stable atomic displacements: four holes which regroup themselves as double, triple, and quadruple holes as well as four interstitials which remain either isolated or regroup themselves as double, triple, and quadruple interstitials. Occurrence of single holes and groups of five interstitials is possible but not likely. Temperature effects during irradiation on dimensional changes of the graphite are described. The model also accounts for dose rate effects, such as instantaneous flux. At low temperatures, the theoretical treatment equals the empirical one and it yields good extrapolations for temperatures beyond 300°C. As a general rule, and as a first approximation, a temperature rise of 7.5% in degrees K compensates a tenfold increase in flux, at a given fluence. (tr-auth)

2993 POLARIZED LIGHT MICROSCOPY TECHNIQUE APPLICABLE TO TEST THE RECRYSTALLIZATION OF GRAPHITES. Dibee, J. M. (Chase Brass and Copper Co., Cleveland). pp 83-9 of Proceedings of the Fourth Annual Technical Meeting. McCall, James L. (ed.). Northglenn, Colo.; International Microstructural Analysis Society, Inc. (1972).

From fourth annual meeting of the International Metallographic Society; Denver, Colo. (21 Sep 1971). See CONF-710902.

Polarized light microscopy is used to test the recrystallization of graphite. The isotropic areas (nongraphitized) reflect the polarized light without any change in the plane of polarization. An anisotropic area (graphitized), on the other hand, rotates the plane of polarization of the reflected light. It is essential to obtain a good surface finish yet prevent the removal of the graphite particles which are attached loosely in the matrix. These fragile particles become detached during polishing and pull off, leaving a cavity which can be easily mistaken for a porous hole. Also, the presence of porous holes in the graphite matrix causes extra difficulties during the sample preparation. For these reasons, it is apparent that a vacuum impregnation technique, whereby the porous holes are filled and loose particles are firmly entrenched in the matrix, is essential. An impregnation apparatus was constructed from a modified vacuum desiccator, a vacuum glass chamber, and a Welsh vacuum diffusion pump. Several epoxy resin mixtures were used as impregnation media. A mixture of Epon 815, Epon 812, and allyglycidyl ether with DMP-10 hardener was the most satisfying impregnation medium. The vacuum impregnation of graphite, together with the polarized light used to test graphitization, is discussed. (auth)

2994 MECHANISM OF PARTICLE EMISSION FROM GRAPHITES DURING PULSED LASER HEATING. Meyer, R. T.; Lynch, A. W. (Sandia Labs., Albuquerque, N. Mex.). High Temp. Sci., 4: No. 4, 283-9(Aug 1972).

Pulsed laser heating of Pyroid, Poco, ATJ, and SPK graphites has revealed differences in particle emission, surface cratering, and mass loss and extensive hydrocarbon volatilization. Particulate mass loss was more prevalent for the conventional graphites than for the pyrolytics. The magnitudes of these effects correlated with the residual hydrogen and/or hydrocarbon content and with the microstructural character of the bulk material. Both of these properties are believed to be associated with the synthesis procedures and the degree of graphitization. It is proposed that the hydrogen-containing species are quenched out of the gaseous C/H equilibrium during the carbon deposition for the pyrolytic graphites and are trapped in the matrix during the decomposition of binder material for the conventional graphites. Preferential vaporization of the binder phase for conventional graphites is attributed to a higher H/C ratio in the binder material than in the filler particles. (auth)

2995 TWINNING IN U_3Si. Bethune, B.; Bevis, M. (Univ. of Liverpool). J. Nucl. Mater.; 44: No. 3, 347-9(Sep 1972).

U_3Si is formed by a peritectoid reaction at 930°C between uranium and U_3Si_2. On cooling the U_3Si undergoes a reversible allotropic transformation from ordered face-centred cubic to ordered body-centered tetragonal at 765°C. The stresses introduced by this transformation are accommodated by the formation of deformation twins. The crystallography of twinning in U_3Si has been investigated and the results of a previous investigation with which they are at variance. (T.F.D.)

2996 EXPERIMENTAL IMPROVEMENT OF CALORIMETER FOR HIGH TEMPERATURE MEASUREMENT OF SPECIFIC HEAT OF SOLID ZrF_4 AS FUNCTION OF TEMPERATURE AND ESTIMATION OF THE HEAT CONTENT OF LIQUID ZrF_4. Fontana, A.; Winand, R. (Univ. Libre, Brussels). J. Nucl. Mater.; 44: No. 3, 295-304(Sep 1972). (In French).

The description of the drop calorimeter comprises the thermal study and the calibration of the apparatus between 500 and 1077°C. The constant of the calorimeter is 17.15 cal/°C at 1030°C. At the maximum sensitivity of the calorimeter, the stability of the measuring circuit leads to errors lower than 0.07 cal. The heat content of ZrF_4 was determined between 500 and 1077°C. The average heat capacity of ZrF_4 between 25 and 908°C is 23.7 ± 3 cal/°K mole. The heat content of liquid ZrF_4 at 908°C (under pressure) is estimated to be 36.3 ± 6 kcal/mole. (auth)

2997 CALORIMETRIC STUDY OF ENTHALPIES OF MIXTURE OF NaF AND ZrF_4 AT 1030°C. Fontana, A.; Winand, R. (Univ. Libre, Brussels). J. Nucl. Mater.; 44: No. 3, 305-12(Sep 1972). (In French).

The molar partial enthalpies of dissolution of NaF and ZrF_4 in $NaF-ZrF_4$ mixtures at 1030°C were determined by use of an isoperibol drop calorimeter. By the Bakjuis Rooseboom method, the total molar enthalpies of the fused mixtures $NaF-ZrF_4$ were calculated. Determination of the heat capacity of the fused $NaF-ZrF_4$ mixtures at 1030°C leads to the total molar enthalpies of the mixtures at 25°C. The heat of formation of $NaF-ZrF_4$ mixtures at 25 mole % ZrF_4 is as high as 7 kcal/mole at 1030°C. (auth)

2998 METHOD OF BONDING HOLLOW FIBERS TO PLASTIC RESIN SUPPORTS BY RADIATION GRAFTING. Harmer, D. E.; Jarema, J. R.; Leng, D. E. (to Dow Chemical Co.). U. S. Patent 3,697,351. 10 Oct 1972. Filed 19 Mar 1968.

An invention is described which provides an improved process for bonding a resin support or header to embedded hollow fibers. The process comprises exposing the resin and the hollow fiber to high energy radiation to cure the resin whereby radiation grafting chemically unites the hollow fiber to the resin. By chemically uniting the polymer chains of the potting resin with those comprising the outside layers of the fiber walls severe swelling stresses can be endured. The invention relates to the use of unsaturated thermosettable resins and hollow fibers prepared from a variety of polymeric materials. (Official Gazette)

2999 DEVELOPMENT OF GRAPHITE/POLYIMIDE COMPOSITES. Stuckey, J. M.; Scheck, W. G. SAMPE Quart.; 9: No. 4, 22-9(Jul 1972).

Development of the HT-S/RS6234 graphite/polyimide system is described. Processing techniques for vacuum bag, vacuum bag-press augmented, and vacuum bag-autoclave augmented have been developed. Preliminary design properties for the HT-S/RS6234 resin system were developed at -320, 75, and 600°F. The processing techniques and the materials developed during this program are all directly applicable to the fabrication of large structural components such as would be required for the space shuttle and other advanced space vehicles. (auth)

3000 EPR STUDIES OF RADIATION DAMAGE IN HYDROGEN-IMPREGNATED GLASS. DiSalvo, R.; Roy, D. M.; Mulay, L. N. (Pennsylvania State Univ., University Park). J. Amer. Ceram. Soc.; 55: No. 10, 536-7(Oct 1972).

Comparison of the EPR spectra from gamma-irradiated H_2-impregnated glass with unimpregnated glass showed that the resonance is greatly reduced by the addition of hydrogen. In SiO_2, silicates, borates, and borosilicate glasses nonbridging oxygen ions may be either present initially or form photochemically and act as hole traps. Hydrogen in the sample reacts with the paramagnetic species to quench the radiation damage. (J.R.D.)

3001 GAMMA-RAY-IRRADIATION METHOD APPLIED TO THREE-DIMENSIONAL THERMAL PHOTOELASTICITY. Gross-Petersen, J. F. (Technical Univ., Lyngby, Denmark). Exp. Mech.; 12: No. 9, 414-19(Sep 1972).

It has recently been shown that gamma irradiation fixes the birefringence in photoelastic models of Araldite B. The method has hitherto only been used to fix the birefringence in specimens subjected to constant forces. This work applies the irradiation method to determine the thermal stresses in a thick-walled cylinder with a temperature gradient along the radius. The model behaved in the following way during the experiment: the material relaxed when the temperature gradient was applied, and the model was irradiated when it was stress free and real stresses, which were equal to the thermal stresses but with opposite sign, appeared when the temperature gradient was removed. As the problem is mathematically two-dimensional, it is possible to determine the birefringence by means of the slicing technique. Good agreement was obtained between the stress determined experimentally and those calculated analytically. The irradiation sensitivity of a number of materials was determined, and some new materials were used that are superior in two important ways to those used earlier in that they require a much lower irradiation dose and their mechanical properties are considerably better. (auth)

3002 NaCl–$PbCl_2$–UCl_4 SYSTEM. Desyatnik, V. N.; Mel'nikov, Yu. T.; Nichkov, I. F.; Raspopin, S. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Zh. Neorg. Khim.; 17: No. 10, 2789-91(Oct 1972). (In Russian).

Phase composition diagrams were constructed for the binary system $PbCl_2-UCl_4$ and the ternary system $NaCl-PbCl_2-UCl_4$. The binary system contained one eutectic (~37% UCl_4, melting at 345°C) and one incongruently melting compound, $4PbCl_2 \cdot UCl_4$. The ternary system contained five fields, with one eutectic and two peritectic points. (K.S.W.)

3003 MELTING POINT DIAGRAMS FOR THE RbCl–UF_4 AND CsCl–UF_4 SYSTEMS. Desyatnik, V. N.; Raspopin, S. P.; Trifonov, I. I. Zh. Neorg. Khim.; 17: No. 10, 2809-11(Oct 1972). (In Russian).

In a study of the binary system $RbC-UF_4$, three compounds ($2RbCl \cdot UF_4$, $3RbCl \cdot UF_4$, and $RbCl \cdot UF_4$) and two eutectics (melting at 515°C – 73 mole % RbCl, and 655°C – 28 mole % RbCl) were detected. A study of the binary system $CsCl-UF_4$ revealed a congruently melting compound $2CsCl \cdot 3UF_4$, and two eutectics (melting at 555 and 660°C, corresponding to the values 55 and 26 mole % CsCl). (tr-auth)

3004 RADIATION EFFECTS IN NUCLEAR GRAPHITE. Suzuki, Hiroshige (Tokyo Inst. of Tech.). Seramikkusu: 7: No. 1, 45-56(Jan 1972). (In Japanese).

Carbon materials used for high-temperature gas-cooled reactors (HTGR) are described, in which the outlet temperature of helium coolant is 750 to 850 or 1000°C. Various changes resulting from radiation damage are considerably different according to irradiation temperature and structural details of the material. Therefore, formation of general lattice defects, types of the defects and influence given to crystal form and dimension are described. Next, changes of property due to the defects are explained about modulus of elasticity, strength, hardness, thermal conductivity, coefficient of thermal expansion, and creep. Radiation effect on pyrocarbon for coating fuel particles, bonding carbon combining the pyrocarbon to form fuel cartridge, and graphite for moderator are described in detail. Recently in Europe, investigation seems to have reached to the level of being established, and there is almost no room for doubt in that the HTGRs can be designed with much safety, and show performance as expected. (Japan)

NUCLEAR MATERIALS AND WASTE MANAGEMENT

Accountability and Safeguards

Refer also to abstract 2566.

3005 (BNWL-SA-4389) ROBUSTNESS OF TANK CALIBRATION SLOPE ESTIMATES. Stewart, K. B. (Battelle Pacific Northwest Labs., Richland, Wash.). [nd]. 32p. (CONF-720840-1). Dep. NTIS.

From Accuracy of nuclear materials accountancy and technical effectiveness of safeguards conference; Vienna, Austria (28 Aug 1972).

Results of studies concerning the magnitude of error models used in tank calibration are presented. Models are described for tank volumes as a function of manometer data, and discussions are presented on effects of incorrect error models. Models of measurement variance proportional to amounts added in tanks, measurement variance constants, and independent measurements are examined. (J.R.D.)

3006 PROCESS FOR CONTROLLING THE SUBSISTENCE OF REFINED NUCLEAR FUELS INDEPENDENTLY OF THEIR FORM OF CONFIGURATION. (to Gesellschaft fuer Kernforschung mbH). Belgium Patent 717,451. 1 Jul 1968. Priority date 1 Jul 1967, Germany. (In French).

A procedure for the control of enriched nuclear fuel which is independent of shape and configuration is described. The procedure consists of the addition of radionuclides to the nuclear fuel before shipment from the enrichment installation. The added nuclides have a predetermined radiation spectrum, they correspond to the weight of the fuel material, and they are homogeneously distributed. As an example, the addition of ^{228}Th is given, the daughter product of which, ^{208}Tl, emits γ radiation of 2.6 MeV. (H.B.G.)

Disposal and Storage

Refer also to abstracts 2443 and 2522.

3007 (ORP/SID-72-4, pp 66-86) WASTE MANAGEMENT. Hogg, R. M. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

Waste management in a light water reactor is discussed, and new equipment designed to further reduce the already low waste discharge from a nuclear steam system is described. Data from the operation of 3 BWR's and 5 PWR's are given and include: stack exhaust rate; condenser water flow rate; average tritium discharge in liquid wastes during 1968 and 1969; cumulative amount of wastes buried from 1962 to 1971; annual gaseous and liquid waste discharges; equipment and methods for handling and shipping wastes; ^{85}Kr separation and release to atmosphere; and tritium release. It is estimated that the probable dose to the population from tritium produced by nuclear reactors will be about 0.001 mRem/y in the year 2000 which may be compared with the current wholebody dose limit of 500 mRem/y. (L.C.L.)

3008 SPACE DUMPING. EXTRA-TERRESTRIAL CONTAMINATION, POLLUTION, AND WASTE DISPOSAL. Ehricke, K. A. (North American Rockwell Corp., Downey, Calif.). Environ. This Mon.; 1: No. 1, 36-45 (Jul 1972).

It is stated that space utilization will grow rapidly in the decades ahead and that an environment-conscious approach to space operations is necessary. Space environments are characteristically different. This makes possible their utilization for activities that are undesirable or unacceptable in the biosphere. On the other hand, thoughtless use of space as a sink for earth wastes would have detrimental consequences. Priceless scientific evidence could be destroyed and future space operations for the benefit of mankind endangered. Possibilities of disposal into the sun or to interstellar space are discussed. (auth)

Handling Equipment and Procedures

Refer also to abstracts 2511 and 2515.

3009 (ARH-SA-76) CALCULATED CRITICAL ARRAYS OF FISSILE MATERIALS. Ridgway, K. R. (Atlantic Richfield Hanford Co., Richland, Wash.). Oct 1970. Contract AT(45-1)-2130. 19p. (CONF-701102-27). Dep. NTIS.

From Meeting of the American Nuclear Society; Washington, D. C. (15 Nov 1972).

To safely ship and store large numbers of fissile units, the reflected array critical size must be determined for each mass, spacing and internal moderation of the subcritical unit under consideration. The results of Monte Carlo calculations using both the GEM 4 and KENO codes for critical arrays of 2, 3 and 4 kg spherical plutonium metal pieces and critical arrays of 10 liter (L-10) and 3 liter (L-3) Dow-type shipping containers of ^{233}U nitrate and plutonium nitrate solutions are presented. (T.F.D.)

3010 (CEA-CONF-2020) MACROGRAPHIC APPARATUS IN HOT CELLS. Janvier, J.-C.; Vignesoult, N.; Houdaille, B.; Gayet, B.; Colombe, G. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 19p. (In French). (CONF-720649-1). Dep. NTIS (U. S. Sales Only).

From 14th Committee of Hot Laboratories of EURATOM; Petten, Netherlands (8 Jun 1972).

Two types of apparatus are projected for high-activity laboratories of the French Atomic Energy Commission. They differ essentially in their resolution and can be considered as complementary. One of them is used to study the possibility of photographing large irradiated samples with a diameter of 31 mm; the magnification can vary from 2 to 10. The other possesses only a magnification of 10 but its optical performance is pushed to the limits of defraction phenomena. (tr-auth)

3011 (CEA-CONF-2054) USE OF RADIOACTIVE ISOTOPES OF FISSION GAS AS A MEANS OF MEASUREMENT. Bazin, Jean; Fremiot, Claude; Gayet, Bernard; Janvier, J.-C.; Kryger, Bernard (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). 1972. 21p. (In French). (CONF-720649-2). Dep. NTIS (U. S. Sales Only).

From 14th Committee of Hot Laboratories of EURATOM; Petten, Netherlands (8 Jun 1972).

The various hot laboratories of the Atomic Energy Commissariat developed techniques for post-irradiation testing. These techniques are based on the measurement of various isotopes in fission gases by either γ or β spectrometry. Application of these methods to the fuel in different rods necessitated a search for new counting techniques and spectrum analysis to improve precision. Their range of practical application comprises the measurement of burnup, concentration profiles in massive fuels, fission gas emitted by coated particles, and the temperature of metal claddings. (tr-auth)

3012 WASTE PROCESSING TV PROBE CAMERA (15 Feb 1972) (Engineering Materials). (Richland Operations Office (AEC), Wash.). (CAPE-2283).

5 drawings.

The design of a device for use in making video tapes of the interior of high- and low-level radwaste storage tanks is presented. The storage tanks are located at the AEC Hanford Plant in facilities operated by the Atlantic Richfield Hanford Company under contract to the AEC. (auth)

3013 HEAVY DUTY ASSAY TABLE (25 Sep 1972) (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). (CAPE-2270).

6 drawings.

This series of drawings shows the construction of a turntable device designed to support and rotate large, rectangular material boxes (i.e., 42 in. by 48 in. by 49 in.) weighing up to 1000 lbs. This facilitates the nondestructive nuclear assay of large and heavy samples of radioactive material. The design provides 180° of rotation, stop and return to initial loading position. Manual starting is required for both directions of rotation. Stopping of turntable is automatic. Loading of turntable is by conventional forklift truck. (auth)

3014 INTRODUCTION TO RADIATION PROTECTION. Martin, A.; Harbison, S. A. London; Chapman and Hall Ltd. (1972). 216p.

The subject is dealt with in sections: structure of matter; radioactivity; radiation units; biological effects of radiation (basic human physiology, cell biology, interaction of radiation with cells, somatic effects, genetic effects); natural and man-made radiation; maximum permissible doses (recommendations of I.C.R.P., planned special exposures, abnormal exposures in emergencies or accidents, exposure of population); radiation detection and measurement; external radiation hazard (shielding, neutron sources, personal dose control, radiation survey monitoring, personnel monitoring equipment, radiation records); internal radiation hazard (uncontained radioactivity, routes of entry, control of contamination hazard, routine control of contamination, radiotoxicity and laboratory classifications, design of areas for radioactive work, treat-

ment of contaminated personnel, contamination monitoring); nuclear reactor health physics (reactor systems, refuelling reactors, radiation hazards from reactors, fuel storage ponds, transport of irradiated fuel); radioactive waste (consequences of releases of radioactivity, storage and disposal of radioactive waste, regulations); x-rays and radiography (x-ray equipment, protection against x-rays, monitoring of x-ray installations); radiation protection in medicine (protection against sealed and unsealed sources, control and disposal of radioactive materials); legislation and transport regulations (Common Law, history of legislation, regulations under the Factories Act, the Nuclear Installations Acts, 1965 and 1969, Radiological Protection Act, 1970, transport of radioactive materials, codes of practice); health physics laboratory techniques (radioassay, calibration of radiation monitors); radiological emergencies (loss of shielding, loss of containment, uncontrolled criticality, pre-planning for emergencies); organization and administration of health physics services (standards, regulations and codes, design and operation, the health physics organization, documents and reports, training). (UK)

3015 HOMOGENEOUS CRITICAL ASSEMBLIES OF 2 AND 3 PERCENT ^{235}U-ENRICHED URANIUM IN PARAFFIN. Raffety, S. J. (Oak Ridge National Lab., Tenn.); Mihalczo, J. T. Nucl. Sci. Eng.; 48: No. 4, 433-43(Aug 1972).

A series of clean critical experiments was performed with homogeneous mixtures of finely divided UF_4 containing either 2 or 3 wt% ^{235}U dispersed in paraffin with $H/^{235}U$ atomic ratios varying from 133 to 972. The assemblies were constructed in rectangular geometry, and minimum critical masses and volumes in cylindrical and spherical geometries were obtained from buckling conversions. The minimum critical spherical volumes of a 2% enriched UF_4-paraffin mixture when unreflected and when reflected with an effectively infinite solid hydrogenous material are 199 and 138 liters, respectively, and the minimum critical ^{235}U masses are 7.5 and 5.4 kg, respectively. The experiments with the 3% UF_4-paraffin mixtures were not extensive enough to determine experimentally the values at optimum moderation, but transport theory calculations indicate that the unreflected and reflected minimum critical volumes are about 93 and 57 liters, respectively, and that the minimum critical masses are about 4.1 and 2.7 kg of ^{235}U, respectively. Measurements of the ^{238}U-to-^{235}U fission ratio indicated that in some assemblies as much as 6.5% of the fissions occurred in ^{238}U. Prompt-neutron decay constants, $\alpha = \beta_{eff}/l$, were measured in reflected and unreflected delayed-critical assemblies of several fuel mixtures by the pulsed-neutron technique; the infinite-medium neutron multiplication factor, k_∞, for the various fuel mixtures was inferred from height perturbation measurements. Transport theory calculations of k_∞ and k_{eff} were made using various cross-section sets. (23 references) (auth)

3016 CONVENIENT METHOD FOR REMOVAL OF RADIOACTIVE CONTAMINATION IN PARTICULATE FORM. Bacon, J. A.; Wade, L. (UT-AEC Agricultural Research Lab., Oak Ridge, Tenn.). Health Phys.; 23: No. 6, 855(Dec 1972).

The decontamination of both horizontal and vertical concrete surfaces on which $^{90}Sr-^{90}Y$ had been spilled some time previously, thus allowing the contamination to become absorbed onto dust particles, has been carried out using a commercial shaving cream in an aerosol can. The same product was also used to prevent contaminated flying chips and dust while a small highly contaminated area was chiseled out. The method is highly recommended. (UK)

3017 SIMPLE APPARATUS FOR DISSOLUTION AND FILTRATION OF SMALL AMOUNTS OF RADIOACTIVE MATERIAL. Soyka, W.; Erdtmann, G. (Kernforschungsanlage, Juelich, Ger.). Radiochim. Acta; 17: No. 3, 171-2(Oct 1972). (In German).

A device is described which permits the safe opening of reactor irradiated quartz ampoules and the quantitative dissolution of the radioactive substances contained in these ampoules. The risk of contamination as well as of spreading of the activity is very much reduced. (auth)

Transportation

3018 (CONF-720445) SPECIALISTS' MEETING ON HANDLING AND TRANSPORTATION OF SPENT FUEL ELEMENTS FOR LMFBR'S, ROME, 26–28 APRIL 1972. (International Atomic Energy Agency, Vienna (Austria)). Nov 1972. 84p. Dep. NTIS.

Seven papers were presented at the conference; a separate abstract was prepared for each paper. (L.C.L.)

For abstracts of individual papers see: 3019–3025.

3019 (CONF-720445–, pp 16-26) CASK DESIGN FOR SPENT SNR FUEL ELEMENTS. Christ, R. (Transnuclear GmbH, Wolfgang, Ger.). Nov 1972.

From Specialists' meeting on handling and transportation of spent fuel elements for LMFBR's; Rome, Italy (26 Apr 1972).

A study was performed to evaluate the use of LWR fuel cask technology for the transport of spent fast breeder reactor fuel elements. Cask design requirements under normal and accident conditions and the heat transfer characteristics needed in fast breeder reactor fuel casks are discussed. It is concluded that the use of LWR cask technology for LMFBR fuel shipping offers reliable solutions for the cases where short decay times before transport are not or not yet mandatory. It is understood, however, that this is no longer valid for shipments of large amounts of fast breeder fuel elements after short decay times, therefore, experiments are being prepared to evaluate liquid heat transfer media, including sodium, lead alloys, and organic coolants and to study steel as an alternative shielding material. (L.C.L.)

3020 (CONF-720445–, pp 27-32) HANDLING AND LOADING OF IRRADIATED SNR-300 ELEMENTS. Wagner, J. (INTERATOM, Bensberg, Ger.). Nov 1972.

From Specialists' meeting on handling and transportation of spent fuel elements for LMFBR's; Rome, Italy (26 Apr 1972).

Criteria for designing casks for shipping spent SNR fuel elements and procedures for handling and loading these shipping containers are described. (L.C.L.)

3021 (CONF-720445–, pp 40-3) ASPECTS OF INTERNATIONAL RECOMMENDATIONS ON FAST-REACTOR FUEL SHIPMENTS. Aubert, M. (CEN, Cadarache, France). Nov 1972.

From Specialists' meeting on handling and transportation of spent fuel elements for LMFBR's; Rome, Italy (26 Apr 1972).

Comments are given on the 1967 edition of IAEA recommendations on fast reactor fuel shipments, proposed revisions to these recommendations, and the special safety requirements under impact shock and fire conditions of shipping casks containing high levels of radioactivity in the presence of sodium. (L.C.L.)

3022 (CONF-720445–, pp 44-67) FRENCH EXPERIENCE IN TRANSPORTING IRRADIATED FAST REACTOR FUEL ELEMENTS. Labrousse, M. (CEN, Fontenay-aux-Roses, France). Nov 1972.

From Specialists' meeting on handling and transportation of spent fuel elements for LMFBR's; Rome, Italy (26 Apr 1972).

The design and performance of shielded containers for shipping spent fuel elements from the Rapsodie Reactor are described. Several thousand highly irradiated rods have been transported from one end of France to the other with no problem whatever, and, of course, without accident, or even minor incident. Nevertheless, one must be aware that the conditions of this transportation are rather different from those which have to be observed with irradiated fuel elements of commercial reactors. To resolve problems of criticality and temperature at the same time, it is necessary to transport stacks under sodium. To remove the heat will no doubt necessitate, as with the containers for light water fuel elements, systems for artificial cooling. The presence of sodium and a highly toxic fissionable material, and the possibility, in the event of accident, of loss of coolant, will require confinement precautions still more severe than in the cases of graphite-gas and light water fuel elements. But these precautions will undoubtedly be easier to observe since it does not appear that the desirability of having containers of very large capacity is as great as in the latter two cases. (L.C.L.)

3023 (CONF-720445–, pp 68-71) PROBLEMS IN RECEIVING FAST REACTOR FUEL ELEMENTS AT REPROCESSING PLANTS. Lenail, B. (CEN, Fontenay-aux-Roses, France). Nov 1972.

From Specialists' meeting on handling and transportation of spent fuel elements for LMFBR's; Rome, Italy (26 Apr 1972).

For several years spent fuel elements from the Fortissimo and Rapsodie fast reactors have been transported to the Hague for reprocessing. The equipment and methods used for unloading and handling these shipments are described. The problems anticipated in handling future, beginning in 1974 or 1975, shipments of Phenix fuel elements without sodium and Phenix fuel elements transported under sodium are discussed. (L.C.L.)

3024 (CONF-720445–, pp 72-4) EXPERIMENTAL TRANSPORT OF DUMMY FUEL SUBASSEMBLIES FOR "JOYO." Uchida, I. (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Nov 1972.

From Specialists' meeting on handling and transportation of spent fuel elements for LMFBR's; Rome, Italy (26 Apr 1972).

Transport experiments with dummy fuel subassemblies for the Japanese experimental sodium-cooled fast reactor, Joyo, are

briefly described. The dummy fuel cores were transported 30 mi by truck. The vibrating characteristics of various parts of the subassemblies were observed. No significant deformation was found after transport. (L.C.L.)

3025 (CONF-720445–, pp 75-84) TRANSPORTATION OF LMFBR FUEL ELEMENTS. **Henry, K. J.** (United Kingdom Atomic Energy Authority, Risley, Eng.). Nov 1972.

From Specialists' meeting on handling and transportation of spent fuel elements for LMFBR's; Rome, Italy (26 Apr 1972).

The development of shielded containers for shipping spent fuel elements from future LMFBR's in the UK is described. Information is included on design specifications, shielding requirements, heat transfer and temperature characteristics, and the proposed testing program. The design study for the CFR Irradiated Fuel Transport Flask has proceeded to the stage where it is considered feasible to provide a design capable of carrying 5 CFR-type irradiated fuel subassemblies with a total heat rating of 40 kW and which will meet the requirements of the current Type B container transport regulations. More consideration must be given to the development of a system for forced cooling of the shipping cask and to possible accident conditions during shipment on public transportation systems, especially on future very high speed trains. (L.C.L.)

3026 SPENT FUEL TRANSPORTATION RISKS. **Yadigaroglu, G.; Reinking, A. G.; Schrock, V. E.** (Univ. of California, Berkeley). Nucl. News; 15: No. 11, 71-5(Nov 1972).

The risk of relatively large doses to the population in the state of California from transportation of spent fuel appears to be low. The calculations were generally conservative; however, given the large uncertainties in the parameters used for the numerical application, the numbers could well vary by an order of magnitude or more in either direction. Awaiting better statistics and technical data on the magnitude and probability of the releases, the numbers derived should be used only as rough indications of orders of magnitude. The risk to the population is directly proportional to the traffic density. This along the routes, although for congested highways the risk might also be proportional to the traffic density. This suggests that busy highways and routes through densely populated areas should be avoided. Although the number of persons receiving more than the limiting exposure appears to be small, individual exposures would be greatly reduced by evacuation, and its consideration is therefore warranted. Because of the short exposure times involved (at short distances from the source considered) orderly evacuation measures cannot be used, unless advance indications of an imminent release exist. This should be the case, however, in a significant fraction of the accidents since most releases will occur slowly as a result of fire or loss of cooling following a crash. It is imperative, therefore, to establish in advance emergency evacuation procedures. These should be initiated and directed preferably by knowledgeable personnel accompanying the radioactive cargo. In their absence, local authorities should be aware of the actions to take in case of an accident. They should also have knowledge of shipments of radioactive materials in transit. However small the probability of a serious transportation-accident release, it would seem prudent to be prepared to take deliberate action to reduce its consequences. (auth)

3027 LP-50 TRITIUM CONTAINER (10 Jan 1972) (Engineering Materials). (Savannah River Operations Office (AEC), Aiken, S. C.). (CAPE-2279).

4 drawings.

The container is composed of a stainless steel primary container sealed within an aluminum vessel secondary container. The secondary container exists as either a flat cover design of 356 aluminum alloy or a dome cover design of 6061-T6 aluminum alloy. A military standard carbon steel 55-gallon drum carries the containers protected by 4 inches of "Celotex" insulation. The drum is sealed with a bolted closure ring to provide positive closure. No lifting or tie-down devices are provided. (auth)

3028 IMPROVED SHIPPING CONTAINER FOR FISSILE MATERIAL (8 Feb 1966) (Engineering Materials). California Univ., Livermore. Lawrence Livermore Lab.). (CAPE-2276).

6 drawings.

The design of an improved container for shipping fissile materials is presented. The container consists of an aluminum liner, glass insulation, cover, cover assembly, and cover liner. (R.C.K.)

3029 TRANSPORT CONTAINER FOR LARGE RADIOACTIVE SOURCES. **Schulz-Forberg, B.** (Bundesanstalt fuer Materialpruefung, Berlin). Atomwirt., Atomtech.; 17: No. 11, 570-3(Nov 1972). (In German).

Transport containers for large radioactive sources must insure safety of the environment even in the case of severe accidents. Rules and regulations for specification of properties of containers are presented in detail. The proposed transport container for therapy sources of highest activity comprises an inner container with lead shield and an external steel container with a wood covering. It permits safe installation of the large source into the radiation unit without the need for a hot cell. (tr-auth)

PARTICLE ACCELERATORS

Design, Development, and Operation

Refer also to abstracts 2551, 3112, and 3273.

3030 (AEC-tr-7174(Vol.1)) SOVIET CONFERENCE ON CHARGED-PARTICLE ACCELERATORS, MOSCOW, 9-16 OCTOBER 1968. VOLUME I. Vasil'ev, A. A. (ed.) Translation of Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits. 762p. (TT-70-50153(Vol.1); IPST-Cat.-5844(Vol.1); CONF-681029-(Vol.1)). Dep. NTIS.

One hundred eleven papers are contained in this volume grouped under the topics: problems of the development of different types of accelerators, magnets and supply systems, ion and electron sources and dc accelerators, targets, beam separation and transport systems, injection and extraction, air-core and superconducting electromagnets and equipment for magnetic measurements. (C.E.S.)

For titles of individual papers see: 3031-3047, 3082-3111, 3195-3223, 3237-3256, 3290-3297, and 3313-3319.

3031 (AEC-tr-7174(Vol.1), pp 5-11) PROBLEMS OF THE PHYSICS AND ENGINEERING OF ACCELERATORS. Markov, M. A. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3032 (AEC-tr-7174(Vol.1), pp 12-18) TRENDS IN THE DEVELOPMENT OF ULTRAHIGH-ENERGY PROTON ACCELERATORS. Vasil'ev, A. A.; Burshtein, E. L. (Inst. of Radio Engineering, Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3033 (AEC-tr-7174(Vol.1), pp 19-24) DESIGN FEATURES OF THE 200-GeV ACCELERATOR. Livingston, M. S. (National Accelerator Lab., Oak Brook, Ill.). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3034 (AEC-tr-7174(Vol.1), pp 25-34) IMPROVEMENT OF LARGE OPERATING PROTON SYNCHROTRONS (Survey Paper). Gol'din, L. L.; Zenkevich, P. R. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3035 (AEC-tr-7174(Vol.1), pp 35-43) TRENDS IN THE DEVELOPMENT OF ELECTRON CIRCULAR ACCELERATORS (Survey Paper). Kolomenskii, A. A. (Lebedev Inst. of Physics, Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3036 (AEC-tr-7174(Vol.1), pp 44-51) ELECTRON-RING ACCELERATOR PROGRAM AT THE LAWRENCE RADIATION LABORATORY. Allison, R. W. Jr.; Avery, R. T.; Baker, W. R.; (and others) (Univ. of California, Berkeley). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

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3073 (AEC-tr-7174(Vol.2), pp 640-2) REMOTE CONTROL SYSTEM FOR MEASURING THE VERTICAL POSITIONS OF ACCELERATOR MAGNET BLOCKS. Vasyutinskii, I. Yu.; Sal'man, A. G. (Inst. of Physics, Erevan). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

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3074 (CEA-CONF-2018) USE OF ELECTRON ACCELERATORS FOR SURFACE HARDENING TREATMENT OF PAINTS AND VARNISHES. Chabert, J. N.; Muel, J.; Pointud, R. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Oct 1971. 30p. (In French). Dep. NTIS (U. S. Sales Only).

The use of electron accelerators for surface treatments is discussed. The elementary phenomena occurring in the slowing down of electrons are summarized. An electron accelerator consists of the high voltage generator, the accelerator proper (accelerator tube and its pumping system, the system for forming the beam, and the output window), the control pulpit, and the protections. Each of these is described in detail. The hardening of paints and varnishes is then considered. Their composition is given. The effects of oxygen, the thickness of the coating, heat of copolymerization, and dose output on the adherence of the coating to the substrate are summarized. (J.S.R.)

3075 (DNPL/R-19, pp 219-36) FUTURE ELECTRON ACCELERATORS. Crowley-Milling, M. C. (CERN, Geneva). 1971.

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It is pointed out that no new types of accelerators have been thought of in the last few decades, but only modifications and combinations of existing ideas. The present situation is reviewed, together with present proposals and future possibilities. The use of superconducting structures is briefly discussed. It is concluded that electron synchrotrons are probably the "best buy" for energies up to 40 GeV; above 40 GeV investigation into the problems of superconducting structures may be desirable. Some sort of electron-proton colliding beam system may also be desirable, and to minimize the cost this would require either the construction of a proton accelerator at the site of an existing electron accelerator, or more likely the reverse. 5 references. (UK)

3076 (RHEL/R-260) NIMROD OPERATION AND DEVELOPMENT QUARTERLY REPORT, APRIL 1-JUNE 30, 1972. Gray, D. E. (ed.) (Rutherford High Energy Lab., Chilton (England)). Aug 1972. 15p. Dep. NTIS (U. S. Sales Only). UK 20 pence.

The Nimrod beam was on for High Energy Physics Research for 91.9% of HEP scheduled operating time. One experiment was completed and ten continued through in this quarter. A description is given of a new digital control system recently developed and installed on the plunged kicker magnet mechanism associated with the X3 proton beam extraction system. (auth)

3077 THIRD COCKCROFT MEMORIAL LECTURE: THE FUTURE OF NUCLEAR PARTICLE ACCELERATORS. Adams, J. B. (European Organization for Nuclear Research, Geneva). J. Brit. Nucl. Energy Soc.; 11: No. 3, 279-90(Jul 1972).

The development of nuclear particle accelerators from the early machines and the advancement from the cyclotron to the synchrotron are reviewed. The advantages and problems involved in the progress from the constant gradient proton synchrotron such as the 6 GeV Bevatron to the alternating gradient focusing 28 GeV accelerator at CERN are described. The problem of energy waste and the need to achieve high reaction energies led to new developments such as CERN intersecting storage rings and the 300 to 400 GeV alternating gradient proton synchrotron in Chicago. These are described and details are given of the accelerator complex under construction at CERN, where five accelerators will be used to reach, in stages, an energy of 400 GeV. Finally the limitations of the present machines are noted and some attention is given to newer ideas, such as electron ring accelerators, and to the problems to be expected in the future. (UK)

3078 EXPERIMENTAL PROGRAM AT THE PS AND THE ISR. CERN Cour.; 12: No. 9, 271-8(Sep 1972).

A brief description of all the experiments currently under way or being prepared at the 28 GeV proton synchrotron and the intersecting storage rings and a list of available beams and schematic diagrams of the layout in the experimental halls are given. (auth)

3079 RETHINKING THE 300 GeV MACHINE. Adams, J. B. (CERN, Geneva). pp 812-26 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

A review is given of the developments that led to the CERN 300 GeV program and of the technological experience gained from the CERN 25 GeV machine that was used for the design of the 300 GeV machine. (L.B.S.)

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SYNCHROTRONS—parameters of NAL Synchrotron booster (W.H.K.)

3081 COST ESTIMATES FOR A 2-TeV SUPERCONDUCTING ACCELERATOR. Kruger, P. Gerald (Univ. of Illinois, Urbana). pp 1025-55 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

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Auxiliaries and Components

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TRON ELECTROMAGNET. D'yachenko, K. K.; Komar, E. G.; Malyshev, I. F.; Megorskii, D. P.; Mozalevskii, I. A.; Monoszon, N. A.; Nadgornyi, V. P.; Popov, A. V.; Solames, A. A.; Strel'tsov, N. S. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

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One hundred two papers are presented in this volume, grouped under the general subject headings of radioelectronic systems for accelerators, high-power radio-engineering facilities and accelerating systems, particle dynamics and new acceleration methods, and auxiliary technical systems and equipment for various types of accelerators. (R.W.R.)

For titles of individual papers see: 3048-3073, 3113-3153, 3224-3228, 3257-3275, 3298-3307, and 4260.

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3151 (AEC-tr-7174(Vol.2), pp 595-9) PROSPECTS OF USING A SYSTEM WITH AN ARTIFICALLY ANISOTROPIC DIELECTRIC IN HIGH-CURRENT ACCELERATORS. Khizhnyak, N. A.; Lupandin, O. S.; Kovpak, N. E. (Physical-Technical Inst., Kiev). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3152 (AEC-tr-7174(Vol.2), pp 615-22) VACUUM SYSTEM OF AN ACCELERATOR WITH A SMALL-APERTURE CHAMBER. Mints, A. L.; Basalaeva, N. Ya. (Inst. of Radio Engineering, Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3153 (AEC-tr-7174(Vol.2), pp 623-7) VACUUM SYSTEM OF THE EREVAN SYNCHROTRON. Martyugov, G. M.; Popkovich, A. V.; Fefelov, P. A.; Alikhanyan, A. I.; Esin, S. K.; Egiazaryan, A. A. (Inst. of Physics, Erevan). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3154 (LBL-924) SUPERCONDUCTING PULSED DIPOLES FOR FUTURE ACCELERATORS. Gilbert, W. S.; Meuser, R. B.; Toby, F. L. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 4p. (CONF-720908-17). Dep. NTIS.

From 4th international conference on magnet technology; Upton, NY. (19 Sep 1972).

Dipole No. 8 (inside diameter of winding, 3 in.; winding length, 18 in.; thickness of cold iron yoke, 2.2 in.) achieved short-sample performance: central field, 39.2 kG; maximum field in the conductor, 45 kG; current, 1920 A. That performance was maintained for a $\dot{B}$ of 5 kG/sec, corresponding to the voltage limit of the power supply. A higher-voltage power supply having a current limit of 1720 A was used to pulse the magnet to a maximum field of 35 kG at 1 Hz with a $\dot{B}$ of 70 kG/sec. The energy loss per cycle increased by a factor of 1.7 as $\dot{B}$ increased from zero to 70 kG/sec; much of this increase occurred in the iron. The loss in the coil is 40 watts at a peak central field of 35 kG and a frequency of 1 Hz, which for 10 μ diameter niobium titanium filaments corresponds to that calculated from the theory. After being pulsed 4600 cycles—zero to 35 kG to zero—the power loss and transition current were unchanged. The iron-wire flux return yoke is being replaced with a thicker one of laminated electrical steel sheet, and a new magnet is being constructed by an improved method. (auth)

3155 (LNF-72/40) MEDIUM ENERGY PION BEAM MONITORING SYSTEM. Barbini, R.; Faini, S.; Guaraldo, C.; Picozza, P.; Schaerf, C.; Scrimaglio, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 17 May 1972. 11p. Dep. NTIS (U. S. Sales Only).

The construction and operation of a monitoring system for the LNFT-LEALE positive and negative medium energy pion beams are described. The system is based upon the integral measurement of the beam charge, in analogy with Faraday-cup methods used for electron beams. Results of experimental tests are reported together with a discussion of correction methods obtained by Monte-Carlo techniques. (auth)

3156 PROCEEDINGS OF THE THIRD INTERNATIONAL CONFERENCE ON MAGNET TECHNOLOGY, HAMBURG, GERMANY, MAY 19-22, 1970. Hamburg; Deutsches Elektronen-Synchrotron DESY (1970). 1692p. (CONF-700503).

Separate abstracts were prepared for 100 of the 111 papers presented. The remaining 11 papers were previously included in NSA. (W.H.K.)

For abstracts of individual papers see: 2596-2604, 2616-2618, 2634-2641, 2936, 3958-3960, 3080, 3081, 3157-3194, 3229-3235, 3278-3288, 3309-3312, 3327-3333, 4272-4277, and 4330.

3157 FRINGING FIELDS AND IRON SATURATION IN AIR CORE MAGNETS. Bronca, G.; Hamelin, J.; Jaidane, S.; Renard, M. (CEN, Saclay, France). pp 64-82 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The problem of fringing fields in superconducting and air core accelerator magnets due to the cumulative effects of the longitudinal limitation of the coils and effects of the coil end shapes is studied. Also, iron shields effects are briefly discussed. (W.H.K.)

3158 SMALL SCALE COMPUTER PROGRAMS FOR MAGNET DESIGN. Lari, Robert J. (Argonne National Lab., Ill.). pp 175-86 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

COMPUTER PROGRAMS—AIRCOR, N-POLE, and P-POLE, for designing superconducting magnets

MAGNETS—design of superconducting, computer programs for (W.D.K.)

3159 CALCULATION OF THE ELECTROMAGNETIC FORCES ACTING ON THE COILS OF AN ELECTROMAGNET. Schleich, A.; Segessemann, A. (Brown, Boveri and Co. Ltd., Zurich). pp 198-209 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

3160 MAGNETIC SATURATION BEHAVIOUR OF GROOVED POLE PLATES, APPLIED TO A VARIABLE ENERGY ISOCHRONOUS CYCLOTRON. Thimmel, H. M. (AEG-Telefunken, Frankfurt am Main). pp 250-61 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The use of concentric grooves in the hill sectors of the magnets of a variable energy isochronous cyclotron to effect saturation in the iron for field corrections is described. A model magnet for a 45 to 90 MeV deuteron isochronous cyclotron was studied, and results are presented and discussed. (W.H.K.)

3161 LIMITATIONS OF HOMOGENEOUS PLANE HELICAL SOLENOIDS IN HIGH FIELD APPLICATIONS. Carden, P. O. (Australian National Univ., Canberra). pp 271-8 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700 503.

3162 END-EFFECTS COMPENSATION IN THE AUXILIARY MAGNETS OF THE CERN INTERSECTING STORAGE RINGS. Perin, R. (CERN, Geneva). pp 304-24 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The method for end effects compensation for the 176 auxiliary magnets in the CERN ISR (Intersecting Storage Rings) is described. The auxiliary magnets include normal and special radial field magnets, normal and special skew quadrupoles, normal and special skew quadrupoles for the Terwilliger scheme, and sextupoles. (W.H.K.)

3163 DEVELOPMENT OF ACCELERATOR MAGNETS. Livingston, M. Stanley (National Accelerator Lab., Batavia, Ill.). pp 377-95 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The historical development of accelerator magnets is reviewed. Topics include solid-core fixed-field magnets for cyclotrons;

pulsed, ring magnets for synchrotrons; alternating-gradient magnets for synchrotrons; and magnets for large orbit accelerators. (W.D.K.)

3164 TRIUMF CYCLOTRON MAGNET. Otter, A. J. (Univ. of British Columbia, Vancouver); Auld, E. G.; Kiesners, U.; Fredriksson, O. K. pp 404-17 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—design parameters for TRIUMF cyclotron

TRI-UNIVERSITY MESON FACILITY—magnet for, design parameters of (W.H.K.)

3165 PS BOOSTER MAIN BENDING MAGNETS AND QUADRUPOLE LENSES (SPECIAL FEATURES OF A MULTI-GAP MAGNET SYSTEM). Asner, A.; Brianti, G.; Giesch, M.; Lohmann, K. D. (CERN, Geneva). pp 418-65 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

CERN SYNCHROTRON—beam booster injector for, main bending magnets and quadrupole lenses for synchrotron

ELECTROMAGNETIC LENSES—development of quadrupole, for CERN Synchrotron booster

MAGNETS—development of beam bending for CERN Synchrotron booster

SYNCHROTRONS—magnets and quadrupole lenses for CERN Synchrotron (W.H.K.)

3166 NATIONAL ACCELERATOR LABORATORY MAIN RING MAGNETS. Hinterberger, H.; Sheldon, R. (National Accelerator Lab., Batavia, Ill.). pp 490-536 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—development of NAL Synchrotron main ring

NATIONAL ACCELERATOR LABORATORY SYNCHRO—magnets for, development of main ring (W.H.K.)

3167 DESIGN OF A UNIFORM FIELD VARIABLE GAP HEIGHT MAGNET. Lari, Robert J.; Bywater, James A. (Argonne National Lab., Ill.). pp 669-76 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

ARGONNE SYNCHROTRON—magnet for, design of variable gap height beam bending

MAGNETS—design of uniform field beam bending, for ZGS (W.H.K.)

3168 PROBLEMS AND RECENT DEVELOPMENTS CONCERNING AC SUPERCONDUCTING MAGNETS FOR SYNCHROTRON ACCELERATORS. Bronca, G.; Hlasnik, I.; Lefrancois, C.; Perot, J.; Pouillange, J. P. (CEN, Saclay, France). pp 701-67 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—developments in ac superconducting, for synchrotrons

SYNCHROTRONS—magnets for, developments in ac superconducting (W.H.K.)

3169 SUPERCONDUCTING BEAM LINE PROTOTYPE MAGNETS FOR NATIONAL ACCELERATOR LABORATORY. Fast, R. W.; Strauss, B. P.; Cohn, C. M.; Helm, J. R.; Scholefield, E. H. (National Accelerator Lab., Batavia, Ill.). pp 839-46 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—development of superconducting dipole beam line prototype (W.H.K.)

3170 DESCRIPTION OF A 13 T COIL WITH HIGH HOMOGENEITY AND HIGH STABILITY IN RELATION TO TIME. Parouty, J. C. (Thomson-Brandt Co., Paris). pp 902-24 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNET COILS—description of 13-T superconducting, with high continuity and stability (W.H.K.)

3171 REVIEW OF WORK DONE AT CERN ON SUPERCONDUCTING COILS COOLED BY A FORCED CIRCULATION OF SUPERCRITICAL HELIUM. Morpurgo, M. (CERN, Geneva). pp 908-24 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNET COILS—development of superconducting, cooled by forced circulation of supercritical helium (W.H.K.)

3172 EXPERIMENT WITH HOLLOW CONDUCTOR SUPERCONDUCTING MAGNET. Lesmond, C.; Lottin, J. C.; Shimamoto, S. (CEN de Saclay, Gif-sur-Yvette, France). pp 925-36 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNET COILS—description of superconducting, cooled by forced circulation of supercritical helium (W.H.K.)

3173 NIOBIUM–TIN SUPERCONDUCTIVE MAGNET INSERT FOR OPERATION AT 150 kOe WITH FORCED CONVECTION COOLING. Schrader, E. R. (RCA Electronic Components, Harrison, N. J.); Stevenson, R. pp 937-49 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—description of Nb_3Sn superconducting insert, for operation of 150 kOe with forced convection cooling (W.H.K.)

3174 DESIGN OF NIOBIUM–TIN STRIP WOUND MAGNETS. Hancox, R. (Culham Lab., Abingdon, Eng.). pp 950-65 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—design of Nb–Sn strip wound superconducting (W.H.K.)

3175 COOLING EFFECTS AND STABILIZATION IN SUPERCONDUCTING COILS. Bronca, G.; Hlasnik, I.; Neel, J. (CEN, Saclay, France). pp 989-1005 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNET COILS—cooling effects and stabilization in superconducting (W.H.K.)

3176 ECONOMIC LIMIT IN SIZE BETWEEN NONSTABILIZED AND STABILIZED SUPERCONDUCTING SOLENOIDS. Cesnak, L.; Chovanec, F. (Electrotechnical Inst., Bratislava). pp 1006-13 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNET COILS—cryogenic stabilization of superconducting solenoids, economic limit in size for (W.H.K.)

3177 PROPERTIES AND CHARACTERISTICS OF SUPERCONDUCTING MAGNETS FOR A 2 TeV ACCELERATOR. Kruger, P. Gerald (Univ. of Illinois, Urbana). pp 1014-24 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

LINEAR ACCELERATORS—magnets for 2-TeV recirculating, superconducting beam bending

MAGNETS—description of superconducting, for 2-TeV accelerator

SYNCHROTRONS—magnets for 2-TeV, superconducting beam bending (W.H.K.)

3178 FILAMENTARY SUPERCONDUCTORS OF NbTi50: STRUCTURE, PROPERTIES, AND EXPERIMENTAL RESULTS ON COILS. Hillmann, H. (Vacuumschmelze GmbH, Hanau, Ger.); Kuckuck, H. pp 1056-70 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNET COILS—properties of filamentary superconducting Nb–Ti

NIOBIUM ALLOYS AND SYSTEMS—Nb–Ti, superconducting properties of filamentary (W.H.K.)

3179 DEVELOPMENT OF A SUPERCONDUCTING HIGH CURRENT CONDUCTOR: MEASUREMENT TECHNIQUES AND QUALITY CONTROL. Albrecht, C.; Lamatsch, H. (Siemens AG, Erlangen, Ger.). pp 1071-92 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNET COILS—fabrication of superconducting ribbon (W.H.K.)

3180 EXPERIENCE WITH TAPE WOUND Nb_3Sn MAGNETS. Rosner, C. H.; Mains, E. F. (General Electric Co., Schenectady, N. Y.). pp 1093-1107 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—performance of tape wound Nb_3Sn superconducting (W.H.K.)

3181 AC BEHAVIOUR OF TEST COILS WITH NbTi MULTIFILAMENT SUPERCONDUCTORS. Bogner, G.; Salzburger, H.; Franksen, H. (Siemens AG, Erlangen, Ger.). pp 1166-77 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNET COILS—development of multifilament Nb–Ti superconducting ac (W.H.K.)

3182 HIGH-PURITY ALUMINUM-MATERIAL FOR USE IN CRYOMAGNETS. Hannibal, W. D.; Pfundt, H.; Winkhaus, G. (Vereinigte Aluminium-Werke AG, Bonn). pp 1234-43 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

ALUMINUM—purification by organometallic electrolytic and zone melting processes for use in cryomagnets

MAGNET COILS—fabrication of cryogenic, purification of aluminum for (W.H.K.)

3183 MAGNET POWER SUPPLY PRACTICE SINCE OXFORD. Fry, Michael G. J. (Brentford Electric Ltd., Crawley, Eng.). pp 1261-74 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

ACCELERATORS—magnet power supplies for, development of

MAGNETS—power supplies for accelerator, development of

POWER SUPPLIES—development for accelerator magnets, review on (W.H.K.)

3184 HIGH POWER 10 MW DIRECT CURRENT SUPPLY WITH HIGH STABILITY ($\pm 5.10^{-6}$). Haglon, C.; Toumire, E. (Compagnie Electro-Mecanique, Paris). pp 1275-7 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen–Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—power supply for Bitter, high-stability 10-MW dc

POWER SUPPLIES—description of high-stability 10-MW dc, for Bitter magnets (W.H.K.)

3185 CANBERRA HOMOPOLAR GENERATOR AS A POWER SUPPLY FOR HIGH FIELD MAGNETS. Blamey, J. W.; Carden, P. O.; Inall, E. K.; Marshall, R. A.; Newstead, Gordon (Australian National Univ., Canberra). pp 1293-1304 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

ELECTRIC GENERATORS—description of homopolar, as power supply for high field magnets

MAGNETS—power supply for high-field, homopolar generator

POWER SUPPLIES—description of homopolar generator, for high-field magnets (W.H.K.)

3186 STATIC PULSED SUPPLY FOR THE MAGNETS OF THE NEW CERN SYNCHROTRON INJECTOR (PS-BOOSTER). Pahud, J. D. (CERN, Geneva). pp 1313-18 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

CERN SYNCHROTRON—beam injector booster synchrotron, static pulsed supply for magnets for

MAGNETS—power supply for CERN Synchrotron booster, static pulsed

POWER SUPPLIES—description of static pulsed, for CERN Synchrotron booster magnets (W.H.K.)

3187 RESONANT CHARGING PULSED HIGH-VOLTAGE POWER SUPPLY. Brueckner, A. (CERN, Geneva). pp 1319-28 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—power supply for kicker, resonant charging pulsed high-voltage

POWER SUPPLIES—description of resonant charging pulsed high-voltage

RADIATION DETECTORS, SPARK CHAMBER—power supply for, resonant charging pulsed high-voltage (W.H.K.)

3188 IMPROVED HIGH-SPEED DATA ACQUISITION SYSTEM FOR STEADY STATE OR PULSED MAGNETIC FIELD MEASUREMENTS. Berrill, E. C.; Hardek, T. W.; Buckels, C. E. (Argonne National Lab., Ill.). pp 1345-58 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

ACCELERATORS—magnetic field measurements, data acquisition system for

DATA ACQUISITION SYSTEMS—description for magnetic field measurements in accelerators

MAGNETIC PROBES—data acquisition system for steady state or pulsed magnetic field measurements

MAGNETS—field measurements of accelerator, data acquisition system for (W.H.K.)

3189 ORGANIZATION AND USE OF A SMALL-SCALE COMPUTER IN ON- AND OFF-LINE MAGNETIC DATA PROCESSING. Berrill, E. C.; George, R. D.; Algustyniak, A. E. (Argonne National Lab., Ill.). pp 1359-72 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

ACCELERATORS—magnetic field measurements, data processing system for

DATA PROCESSING SYSTEMS—description for magnetic field measurements in accelerators

MAGNETS—field measurements of accelerator, data processing system for (W.H.K.)

3190 SIN RING-CYCLOTRON HIGH SPEED DATA ACQUISITION SYSTEM FOR MAGNET FIELD MEASUREMENTS. Brombach, D. (Schweizeriches Institut fuer Nuklearforschung, Zurich). pp 1373-6 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503).

CYCLOTRONS—magnetic field measurements in SIN ring, data acquisition systems for

DATA ACQUISITION SYSTEMS—description for magnetic field measurements in SIN ring cyclotron (W.H.K.)

3191 AUTOMATIC MEASURING SYSTEM FOR THE CERN-ISR MAIN MAGNET. Henrichsen, Knud N. (CERN, Geneva). pp 1403-11 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

STORAGE RINGS—magnetic field measurements in CERN ISR, automatic system for (W.H.K.)

3192 STRONG FOCUSING MAGNET MEASUREMENTS. Gourber, J. P. (CERN, Geneva). pp 1412-24 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

STORAGE RINGS—magnetic field measurements in CERN ISR, method for (W.H.K.)

3193 AUTOMATED QUADRUPOLE MAGNET MEASURING SYSTEM. Larl, Robert J.; Algustyniak, Alan E.; Lieberg, Mason M.; Wilhelm, Jerome K. (Argonne National Lab., Ill.). pp 1425-38 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

ELECTROMAGNETIC LENSES—magnetic field measurements in quadrupole, automatic system for (W.H.K.)

3194 AUTOMATIC MAGNETIC MEASUREMENT FACILITY FOR SYNCHROTRON MAGNETS. Feng, H.; Malamud, E.; Schivell, J.; Schmidt, C.; Yamada, R. (National Accelerator Lab., Batavia, Ill.). pp 1453-71 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS—field measurements of synchrotron, automatic facility for

SYNCHROTRONS—magnets for, facility for automatic field measurements of (W.H.K.)

Ion Sources and Injection and Extraction Systems

Refer also to abstracts 3056, 3100, 3112, 3294, and 3326.

3195 (AEC-tr-7174(Vol.1), pp 96-103) INTENSITY-DEPENDENT EFFECTS AND SPACE-CHARGE LIMIT INVESTIGATIONS ON THE CERN LINEAR INJECTOR AND SYNCHROTRON. Lapostolle, P.; Taylor, C. S.; Tetu, P.; Thorndahl, L. (CERN, Geneva). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3196 (AEC-tr-7174(Vol.1), pp 109-29) INTENSITY LIMITATIONS OF THE NIMROD ACCELERATOR. Gardner, I. S. K.; Grey, D. A.; Ranft, J.; Rees, G. H. (Rutherford High Energy Lab., Chilton, Eng.). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3197 (AEC-tr-7174(Vol.1), pp 310-12) FORMATION OF CONSTANT AND PULSED FIELDS ON EQUIPOTENTIAL IRON SURFACES IN SYSTEMS FOR TRANSPORTING A BEAM THROUGH A CONSTANT FIELD. Pakin, V. N.; Sil'vestrov, G. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3198 (AEC-tr-7174(Vol.1), pp 313-19) CHOICE OF PARAMETERS FOR THE PULSED MAGNET OF THE FAST-EXTRACTION SYSTEM OF THE SERPUKHOV SYNCHROTRON. Doinikov, N. I.; Ratnikov, B. K.; Stolov, A. M. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3199 (AEC-tr-7174(Vol.1), pp 361-71) HIGH-CURRENT INJECTORS OF PROTON LINACS (Survey Paper). Kuznetsov, V. S.; Solnyshkov, A. I. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3200 (AEC-tr-7174(Vol.1), pp 372-81) ION SOURCES FOR ACCELERATORS. Abroyan, M. A.; Golubev, V. P.; Ivanova, L. I.; Komarov, V. L.; Solnyshkova, Z. G.; Tarvid, G. V.; Tokarev, G. M.; Tsepakin, S. G.; Chemyakin, G. V. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

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3257 (AEC-tr-7174(Vol.2), pp 221-6) SINGULARITIES OF THE CALCULATION OF HIGH-CURRENT RESONANT ELECTRON ACCELERATORS. Vorogushin, M. F.; Petrunin, V. I. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

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3258 (AEC-tr-7174(Vol.2), pp 276-9) GENERALIZED RELATIONSHIPS FOR THE DOMAINS OF EXISTENCE OF MODIFICATIONS OF THE RESONANT RF DISCHARGE WITH ALLOWANCE FOR THE COULOMB FIELD. Mudrolyubov, V. G.; Petrunin, V. I. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3259 (AEC-tr-7174(Vol.2), pp 285-300) COLLECTIVE EFFECTS IN ACCELERATORS (Review Article). Kolomenskii, A. A.; Lebedev, A. N. (Lebedev Inst. of Physics, Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3260 (AEC-tr-7174(Vol.2), pp 301-11) LONG-TERM STABILITY FOR PARTICLE ORBITS. Laslett, L. J. (Univ. of California, Berkeley). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3261 (AEC-tr-7174(Vol.2), pp 317-21) INSTABILITY OF THE BEAM SHAPE IN CIRCULAR ACCELERATORS AND IN STORAGE RINGS OWING TO THE FINITE CONDUCTANCE OF THE CHAMBER WALLS. Korenev, I. L.; Roginskii, L. A.; Yudin, L. A. (Inst. of Radio Engineering, Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3262 (AEC-tr-7174(Vol.2), pp 322-6) EXPERIMENTAL STUDY OF THE FEASIBILITY OF STABILIZATION OF THE BETATRON OSCILLATION AMPLITUDE AT THE RESONANCE $Q_r = 2/3$. Kulikov, O. F.; Metal'nikov, Yu. N.; Shorin, K. N. (Lebedev Inst. of Physics, Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3263 (AEC-tr-7174(Vol.2), pp 349-52) SOME PROBLEMS OF THE AUTOMATIC CORRECTION OF BETATRON OSCILLATIONS IN CIRCULAR ACCELERATORS. Burshtein, E. L.; Roginskii, L. A. (Inst. of Radio Engineering, Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3264 (AEC-tr-7174(Vol.2), pp 353-8) INVESTIGATION OF NONLINEAR SYNCHROTRON OSCILLATIONS. Dovbnya, A. N.; Kononenko, S. G.; Reprintsev, L. V.; Shenderovich, A. M. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3265 (AEC-tr-7174(Vol.2), pp 359-66) SYNCHROTRON MOTION IN THE 1000-GeV ACCELERATOR WITH A WAVEGUIDE ACCELERATING SYSTEM. Shal'nov, A. V.; Khlestkov, Yu. A.; Kisletsov, A. V. (Inst. of Engineering Physics, Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3266 (AEC-tr-7174(Vol.2), pp 448-52) MAINTENANCE OF THE PHASE STABILITY ALONG HIGH-CURRENT LINEAR ACCELERATORS. Bondarev, B. I.; Vlasov, A. D. (Inst. of Radio Engineering, Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3267 (AEC-tr-7174(Vol.2), pp 453-60) NUMERICAL INVESTIGATION OF THE DYNAMICS OF A HIGH-INTENSITY PROTON BEAM IN A LINEAR ACCELERATOR. Osipov, V. V.; Shembel, B. K. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3268 (AEC-tr-7174(Vol.2), pp 461-7) INVESTIGATION OF THE PHASE-SPACE DENSITY REDISTRIBUTION IN CHARGED-PARTICLE BEAMS BY MEANS OF NUMERICAL COMPUTATIONS. Kuznetsov, V. S.; Fidel'skaya, R. P.; Kuznetsova, N. P.; Solnyshkov, A. I.; Abroyan, M. A. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3269 (AEC-tr-7174(Vol.2), pp 468-73). PARTICLE DYNAMICS OF A PROTON LINEAR ACCELERATOR OPERATING IN THE H_{11n} MODE. Kovpak, N. E.; Baranov, L. N.; Khizhnyak, N. A.; Zeidlits, P. M.; Lysenko, O. E. (Physical-Technical Inst., Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3270 (AEC-tr-7174(Vol.2), pp 487-92) CALCULATION OF ELECTRON BEAM INSTABILITIES IN A LINEAR ACCELERATOR. Voskresenskii, G. V.; Serebryakov, Yu. N. (Inst. of Radio Engineering, Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3271 (AEC-tr-7174(Vol.2), pp 560-4) PROBLEMS OF THE STABILITY OF THE ELECTRON RING. Ivanov, I. N.; Iovnovich, M. L.; Makhan'kov, V. G.; Perel'shtein, E. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3272 (AEC-tr-7174(Vol.2), pp 565-9) FOCUSING OF AN ELECTRON RING IN A LINEAR COLLECTIVE ION ACCELERATOR. Bonch-Osmolovskii, A. G.; Dolbilov, G. V.; Ivanov, I. N.; Perel'shtein, E. A.; Sarantsev, V. P.; Yarkovoi, O. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3273 (AEC-tr-7174(Vol.2), pp 589-94) ON THE THEORY OF RADIATIVE ACCELERATION OF IONS IN SLOW-WAVE WAVEGUIDES. Khizhnyak, N. A.; Lysenko, O. E. (Physical-Technical Inst., Kiev). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3274 (AEC-tr-7174(Vol.2), pp 600-3) RESONANCE ACCELERATION OF PARTICLES IN A MAGNETIC FIELD BY A PLANE WAVE HAVING A PHASE VELOCITY EXCEEDING THE SPEED OF LIGHT. Voronin, V. S.; Kononov, V. K. (Lebedev Physics Inst., Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3275 (AEC-tr-7174(Vol.2), pp 604-9) POSSIBILITY OF ACCELERATING PARTICLES IN A PLASMA IN THE VICINITY OF THE ZERO-FORCE LINE OF THE MAGNETIC FIELD. Syrovatskii, S. I.; Frank, A. G.; Khodzhaev, A. Z. (Lebedev Physics Inst., Moscow). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3276 (LBL-765) MAFCO III: A CODE FOR CALCULATING PARTICLE TRAJECTORIES IN MAGNETIC AND ELECTRIC FIELDS. Perkins, W. A.; Sackett, S. J. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 25p. Dep. NTIS.

MAFCO III will calculate the three-dimensional trajectory of a relativistic (or non-relativistic) particle of arbitrary mass and charge in time-varying (or constant) three-dimensional magnetic and electric fields. The magnetic fields must be specified by infinitesimal current elements whose configuration and time variation can be very general. Electric fields can be specified by point charges and infinitesimal charged elements which can also have a time variation, and by regions of constant electric field. The electric field due to the time variation of the magnetic field is calculated and added to the specified electric field. The magnetic field arising from a time-varying charged element, however, is neglected. The program is written in FORTRAN and COMPASS and requires a memory allotment of $110,000_8$ words. (auth)

3277 APPROXIMATIVE SOLUTION OF ELECTRON MOTION IN A LINAC (LINEAR ACCELERATOR). Hlubucek, V. (TESLA-Research Inst. of Vacuum Electronics, Prague). TESLA Electron.; 4: No. 1, 8-15(Mar 1971).

An experimental prototype linear accelerator was designed by the Research Institute of Vacuum Electronics to verify certain industrial applications. Main properties are analyzed and the relations are given for the periodic structure and the electron interaction with the r.f. field in an homogeneous structure section. Numerical calculations and the results of the experimental solution of the longitudinal electron motion in the accelerating structure are presented. A computer program was written to compute a number of alternatives of the bunching part of the tube necessary for the determination of the suitable phase velocity of the wave, the field gradient, capture angle, and the length of the bunching part. The measured energy spectra of the accelerator output flow are given. Based on the calculation methods and experimental verification, another accelerator with an energy of 5 MeV and a beam power of approximately 800 W was designed and is being tested at the present time. (NSA of Czech.)

3278 SOME RECENT DEVELOPMENTS IN COMPUTATION OF TWO-DIMENSIONAL FIELDS IN IRON MAGNETS. Iselin, C. (CERN, Geneva). pp 83-99 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference of magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The variational methods, methods of solution, over-relaxation methods, gradient methods, the first order approximation to the energy integral, and a second-order approximation in a triangle grid are discussed for computation of two-dimensional fields in iron magnets. The computer program FATIMA (Field Analysis in Two dimensions for Iron Magnets with Anisotropy) which uses these methods is briefly described. (W.H.K.)

3279 THREE-DIMENSIONAL ANALYSIS OF MAGNETIC FIELDS WITH FIELD-DEPENDENT PERMEABILITY. Halacsy, Andrew A. (Univ. of Nevada, Reno). pp 113-28 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETIC FIELDS — calculation of three-dimensional, with field dependent permeability, computer method for (W.H.K.)

3280 HYSTERESIS EFFECT OF FIELD DISTRIBUTION AND POLE PROFILE IN ELECTROMAGNETS. Kumagai, Hiroo; Motonaga, Shosichi (Inst. of Physical and Chemical Research, Yamato, Japan). pp 168-74 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The hysteresis effect of field distribution by pole pieces of ordinary iron and pure iron and the estimation of $\Delta B/B$ in a rectangular profile are graphed and discussed. (W.H.K.)

3281 SOME REMARKS ON EVALUATING A MAGNETIC FIELD COMPONENT FROM BOUNDARY OBSERVATIONS ONLY. Wind, H. (CERN, Geneva). pp 195-7 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

3282 COMPUTATION OF THE MAGNETIC FIELD OF BETATRON-MAGNETS WITH THE FINITE-DIFFERENCE METHOD. Freundl, H. (AG Brown, Boveri und Cie., Baden, Switzerland); Reichert, K.; Erdelyi, E. A. pp 210-28 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

A computer method for calculating the magnetic field, the field gradient, and the radius of the stable orbit in a betatron for magnet design is described. (W.H.K.)

3283 COMPUTATION OF THE FIELD AND STRAY FIELD DISTRIBUTION FOR A GIVEN MAGNETOSTATIC CONFIGURATION. Riche, J. (CERN, Geneva). pp 229-49 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

3284 PERTURBATIONS FROM STEEL ENVIRONMENT CLOSE TO A C MAGNET. Vogel, Herbert F. (Los Alamos Scientific Lab., N. Mex.). pp 262-70 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The field equations and transformation equations in the complex plane are tabulated in parameter representation. Magnetic fields for various configurations with coils with or without a reflecting iron environment can be computed with the tabulated field equations. Calculations for the 30C11 magnet of the LAMPF muon channel using the TRIM code are briefly discussed. (W.H.K.)

3285 EDDY CURRENTS IN PULSED MAGNETS. Asner, A.; Brianti, G.; Gumowski, I. (CERN, Geneva). pp 279-303 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The influence of eddy currents on the magnetic field of synchrotron pulsed bending magnets formed by a stack of thin laminations limited by thick end plates is studied. The influence of the eddy currents associated with the vertical and the horizontal field components is considered separately. The former, with the limitation of certain simplifying assumptions, is treated rigorously and also in a simplified form. Eddy currents are considered to exist only in the thick end plates. The influence of the eddy currents associated with the horizontal field component is treated approximately, and the thickness of the laminations does not affect the results. (W.H.K.)

3286 RECENT SPECTROGRAPH DESIGN WORK UTILIZING A FOURTH-ORDER RAY-TRACING PROGRAM. Enge, Harald A.; Kowalski, Stanley B. (Deltaray Corp., Winchester, Mass.). pp 366-73 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

A second-order ray-tracing program utilizing step-by-step numerical integration with time as the independent variable was

used by Spencer and Enge in the design work on a split-pole magnetic spectrograph. The program has been upgraded such that aberrations to fourth order can be calculated. It can be used to calculate trajectories through any number of elements, including dipoles, quadrupoles, sextupoles, octupoles, solenoids, etc. By the use of this program, several high-precision magnetic spectrographs have been designed. Two spectrographs with intermediate transverse images (cross-overs) have been designed for nuclear-reaction studies. Both have a solid angle of 15 millisteradians and a calculated resolving power of the order of $\Delta p/p = 10^{-4}$. One has an energy range $E_{max}/E_{min} = 1.2$ and a dispersion $x/\delta = 14$. The other has $E_{max}/E_{min} = 1.5$ and $x/\delta = 10$. A third spectrograph with an intermediate image has been designed for use on the 800-MeV proton linear accelerator being built at Los Alamos Scientific Laboratory. This instrument is an energy-loss spectrometer; that is, it utilizes a dispersion matching at the target position, so that an energy resolution $\Delta p/p$ of better than 1 part in 10^4 can be obtained with a beam momentum spread of ±0.25 percent. (auth)

3287 "MIMI" A COMPUTER PROGRAM FOR THREE-DIMENSIONAL MAGNETIC FIELD PROBLEMS. Caeymaex, S. (CERN, Geneva). pp 396-403 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

COMPUTER PROGRAMS—MIMI, for three-dimensional magnetic field calculations

MAGNETS—field calculations for accelerator and beam bending, computer program for three-dimensional (W.H.K.)

3288 STRONG FOCUSSING IN A MAGNETIC HELICAL QUADRUPOLE CHANNEL. Pearce, R. M. (Univ. of Victoria, British Columbia). pp 1530-42 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

CHARGED PARTICLES—focusing in helical quadrupole electromagnetic lens, strong

ELECTROMAGNETIC LENSES—charged-particle focusing in helical quadrupole, strong (W.H.K.)

3289 RADIATION OF A CHARGED PARTICLE IN A SEMI-INFINITE IRIS-LOADED WAVEGUIDE. Gusarov, V. N.; Serebryakov, Yu. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 5, 785-7(Nov 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 5, 991-4(May 1972).

The radiation excited by a charged particle moving with constant velocity along the axis of a semi-infinite iris-loaded waveguide is studied. The problem is reduced to the simpler but physically equivalent problem of the excitation of an iris-loaded resonant cavity of suitable length. A great simplification of the analysis is achieved in this way. The space–time distributions of the fields generated by the charged particle are calculated on a digital computer allowing for the dispersion properties of the structure. (auth)

Storage Rings

Refer also to abstracts 3078, 3112, 3261, 3262, 3264, 3619, and 3620.

3290 (AEC-tr-7174(Vol.1), pp 130-4) RECENT EXPERIMENTS WITH ACO. Belbeoch, R.; Bergher, M.; Le Duff, J.; Level, M. P.; Marin, P.; Nguygen Ngoc, Ch.; Sommer, M.; Zyngier, H. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3291 (AEC-tr-7174(Vol.1), pp 135-6) REPORT ON THE CURRENT STATE OF ADON. Pellegrini, K. (National Lab., Frascati, Italy). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3292 (AEC-tr-7174(Vol.1), pp 284-8) MAGNET SYSTEM OF THE VEPP-3 STORAGE RING. Budker, G. I.; Kuznetsov, N. A.; Levichev, B. V.; Protopopov, I. Ya.; Skrinskii, A. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3293 (AEC-tr-7174(Vol.1), pp 295-9) CURRENT STABILIZER OF THE ELECTROMAGNET OF THE VEPP-2 STORAGE RING. Karliner, M. M.; Levichev, B. B.; Medvedko, A. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3294 (AEC-tr-7174(Vol.1), pp 541-6) ELECTRON-OPTICAL CHANNEL OF THE VEPP-3 STORAGE RING. Vsevolozhskaya, T. A.; Sil'vestrov, G. I.; Skrinskii, A. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3295 (AEC-tr-7174(Vol.1), pp 602-6) MONOCHROMATIZATION OF A POSITRON BEAM ON A WEDGE-SHAPED MODERATOR FOR INCREASING THE CAPTURE COEFFICIENT OF A STORAGE RING. Budker, G. I.; Vsevolozhskaya, T. A.; Sil'vestrov, G. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3296 (AEC-tr-7174(Vol.1), pp 718-21) MAGNETIC MEASUREMENTS ON THE VEPP-3 STORAGE RING. Levichev, B. V.; Medvedko, A. S.; Protopopov, I. Ya.; Skrinskii, A. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3297 (AEC-tr-7174(Vol.1), pp 750-4) SYSTEM FOR PRECISION MEASUREMENTS OF THE MAGNETIC FIELD IN THE STORAGE RING ELECTROMAGNET. Baklakov, B. A.; Karliner, M. M.; Levichev, B. V.; Medvedko, A. S.; Protopopov, I. Ya. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3298 (AEC-tr-7174(Vol.2), pp 144-8) HIGH-FREQUENCY POWER SUPPLY FOR THE VEPP-2 STORAGE RING. Gorniker, E. I.; Karliner, M. M.; Petrov, V. M.; Petukhov, V. V.; Shekhtman, I. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3299 (AEC-tr-7174(Vol.2), pp 149-54) ACCELERATING RESONATOR FOR THE VEPP-2 ELECTRON–POSITRON STORAGE RING. Veshcherevich, V. G.; Karliner, M. M.; Petrov, V. M.; Sedlyarov, I. K.; Shekhtman, I. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National Particle accelerator conference; Moscow, USSR (9 Oct 1968).

3300 (AEC-tr-7174(Vol.2), pp 408-13) EXPERIMENTS ON THE LOSS OF PARTICLES IN CIRCULAR ACCELERATORS IN TRANSITIONS THROUGH NONLINEAR RESONANCES. Kulipanov, G. N.; Popov, S. G.; Tumaikin, G. M. (Inst. of Nuclear Physics, Novsibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3301 (AEC-tr-7174(Vol.2), pp 414-20) EFFECTS OF A NONLINEARITY UPON THE BETATRON OSCILLATIONS IN A STORAGE RING. Kulipanov, G. N.; Mishnev, S. I.; Popov, S. G.; Tumaikin, G. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3302 (AEC-tr-7174(Vol.2), pp 421-6) EXPERIMENTAL INVESTIGATION OF COLLISION EFFECTS IN A STORAGE RING. Kulipanov, G. N.; Mishnev, S. I.; Popov, S. G.; Tumaikin, G. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3303 (AEC-tr-7174(Vol.2), pp 427-32) TRANSVERSE COHERENT RESONANCE EFFECTS IN STORAGE RINGS. Derbenev, Ya. S.; Dikanskii, N. S. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3304 (AEC-tr-7174(Vol.2), pp 433-8) COHERENT EFFECTS IN THE VEPP-2 STORAGE RING. Auslender, V. L.; Dikanskii, N. S.; Karliner, M. M.; Sedlyarov, I. K.; Skrinskii, A. N.; Shekhtman, I. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3305 (AEC-tr-7174(Vol.2), pp 439-42) ELECTRON COOLING SYSTEM. Arenshtam, A. I.; Budker, G. I.; Meshkov, I. N.; Ponomazenko, V. G.; Skrinskii, A. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3306 (AEC-tr-7174(Vol.2), pp 628-31) ULTRAHIGH-VACUUM PUMPING SYSTEM OF THE VEPP-2 STORAGE RING. Anashin, V. V.; Auslender, V. L.; Bender, E. D.; Blinov, G. A.; Malev, M. D.; Osipov, B. N.; Popov, A. T.; Trakhtenberg, E. M. (Inst. of Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3307 (AEC-tr-7174(Vol.2), pp 643-5) OPTICAL METHODS OF BEAM OBSERVATION. Zinin, E. I. (Inst. of Nuclear Physics, Novosibirsk). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3308 (LBL-1063) STATUS REPORT ON THE LBL-SLAC PROTON-ELECTRON-POSITRON COLLIDING BEAM PROJECT. (California Univ., Livermore. Lawrence Livermore Lab. Stanford Linear Accelerator Center, Calif.). Sep 1972. Contract W-7405-eng-48. 14p. (SLAC-PUB-1109; CONF-721029-2). Dep. NTIS.
From third all-union national conference on particle accelerators; Moscow, USSR (2 Oct 1972).
The work of the joint LBL-SLAC study group on a proton-electron-positron colliding beam facility (PEP) is briefly described. Following a section on the physics which can be done on PEP, the guiding philosophy of the study is outlined, a first reasonably complete machine example is presented, and subjects which have been identified as requiring further study are delineated. (auth)

3309 FIELD DISTRIBUTION IN SEXTUPOLES WITH AN ELLIPTIC APERTURE. Caeymaex, S. (CERN, Geneva). pp 187-94 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).
From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.
The development of the sextupole magnets with elliptic apertures in the CERN ISR is described. Due to the loss of symmetry, multipolar components are generated; and due to end effects a dipole component is dominant. A model sextupole magnet was built and shunts and shims were used to eliminate the dipole component. Pole profiles were computed. (W.H.K.)

3310 CONSTRUCTION OF THE EXCITATION WINDINGS FOR THE INTERSECTING STORAGE RINGS. Pluym, G. (CERN, Geneva); Carlier, J.; Ferry, P.; Goyer, J. pp 466-81 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).
From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.
MAGNET COILS—design and testing for CERN ISR magnets
STORAGE RINGS—magnets for CERN ISR, design and testing of windings for (W.H.K.)

3311 CONSTRUCTION OF THE POLEFACE WINDINGS FOR THE INTERSECTING STORAGE RINGS. Mueller, E. O. (Brown, Boveri und Cie, Mannheim, Ger.); Pluym, G.; Reith, L.; Bieder, H. pp 482-9 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).
From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.
MAGNETS—poleface windings for field corrections for CERN ISR
STORAGE RINGS—magnets for CERN ISR, design of poleface windings for field corrections for (W.H.K.)

3312 WATER-COOLED CABLES AS INTERCONNECTING ELEMENT FOR MAGNETS. Pichler, S. (CERN, Geneva); Richter, S.; Wilck, M. pp 1244-57 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).
From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.
MAGNETS—electric connectors for CERN ISR, water-cooled cable
STORAGE RINGS—magnets for CERN ISR, water-cooled cable connectors for (W.H.K.)

Experimental Facilities

Refer also to abstracts 2554, 3078, 3119, and 4819.

3313 (AEC-tr-7174(Vol.1), pp 487-95) SOME PROBLEMS ASSOCIATED WITH THE DEVELOPMENT OF A WAVEGUIDE SEPARATOR FOR THE 100-GeV CYBERNETIC ACCELERATOR (Survey Paper). Val'dner, O. A.; Glazkov, A. A.; Babkin, B. N.; Budkin, V. V.; Sukharev, Yu. N. (Moscow Engineering Physics Inst.). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3314 (AEC-tr-7174(Vol.1), pp 496-505) NEW TYPE OF ELECTROSTATIC SEPARATOR FOR CERN. Germain, C. (CERN, Geneva). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3315 (AEC-tr-7174(Vol.1), pp 506-12) BACKGROUND PHENOMENA IN THE SEPARATOR CHANNEL OF HIGH-ENERGY PARTICLES. Glazkov, A. A.; Sukharev, Yu. N.; Tron, A. M.; Budkin, V. A.; Braitsev, N. A. (Moscow Engineering Physics Inst.). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3316 (AEC-tr-7174(Vol.1), pp 513-18) BASIC PARAMETERS OF THE BEAM OPTICS FOR THE HIGH-FREQUENCY SEPARATOR OF THE SERPUKHOV ACCELERATOR. Regenstreif, E. (Rennes Univ., France). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3317 (AEC-tr-7174(Vol.1), pp 584-9) CHARACTERISTICS OF THE INTERACTION OF AN ACCELERATED PROTON BEAM WITH THE INTERNAL TARGET OF THE JINR PROTON SYNCHROTRON. Bokov, G. A.; Tsarenkov, A. P.; Shtyrlyaev, V. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3318 (AEC-tr-7174(Vol.1), pp 590-6) HYDROGEN GAS TARGET FOR THE INTERNAL BEAM OF ACCELERATOR. Bartenev, V. D.; Belushkina, A. A.; Zhitkov, N. K.; Zolin, L. S.; Matyushevskii, E. A.; Nikitin, V. A.; Pilipenko, Yu. K. (Joint Inst. for Nuclear Research, Dubna, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3319 (AEC-tr-7174(Vol.1), pp 631-5) EXTERNAL 200-MeV PROTON BEAM OF THE ITEP PROTON SYNCHROTRON. Barabash, L. Z.; Barkhudaryan, A. V.; Blokhin, S. I.; Gol'din, L. L.; Kleinbok, Ya. L.; Lomanov, M. F.; Onosovskii, K. K.; Plyashkevich, L. N.; Khoroshkov, V. S. Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.
From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

3320 (ANL/SSS-72-1) EVALUATION OF THE ZGS INJECTOR-BOOSTER AS AN INTENSE NEUTRON GENERATOR. Car-

penter, J. M.; Marmer, G. J. (Argonne National Lab., Ill.). 19 Apr 1972. Contract W-31-109-Eng-38. 60p. Dep. NTIS.

The possible applications of the ZGS injector-booster accelerator as an intense pulsed neutron source are evaluated. It is suggested to name the facility "ZING." The acronym refers to the major accelerator system, ZGS, of which the booster accelerator is a part, and alludes to the function of the facility, with a bow to the very ambitious Canadian "ING" project, from which comes much of the information and stimulus for the present application. The facility consists of a neutron-producing spallation target, erected on a separate beam line from the high-energy proton booster accelerator which is to be constructed as injector for the ZGS. It could conceivably materialize in about three years. A brief description of the booster accelerator, a description of the characteristics of the spallation neutron source, and an evaluation of the possibilities for applications as a pulsed slow neutron source are presented. The facility would be one of the most intense pulsed neutron sources in the world, both as a fast and as a slow neutron source. (auth)

3321 (BNL-17226) CAN HIGHER πp LUMINOSITY BE OBTAINED AT THE ISA? Palmer, R. B. (Brookhaven National Lab., Upton, N. Y.). 14 Sep 1972. 6p. Dep. NTIS.

A method for increasing π + p interaction rates at ISABELLE is proposed. The method consists of using pulsed horns to focus all pions over a wide momentum range so that experiments are performed in which the interaction region is not fixed. The ultimate theoretical luminosity of π + p interactions is calculated assuming that ideal targeting and focusing can be achieved; and a real design that comes as near to this ideal as possible is considered. (W.H.K.)

3322 (DNPL/R-19, pp 199-217) POSSIBILITIES FOR LEPTON AND PHOTON BEAMS AT THE 300-GeV ACCELERATOR. Allaby, J. V. (CERN, Geneva). 1971.

From Proceedings of the Daresbury study weekend; Daresbury, England (1 Oct 1971).

A brief description of the CERN II Synchrotron and its site are first given, followed by a discussion of possible lepton and photon beams, including electron beams, neutrino beams, and muon beams. It is concluded that there are real possibilities for physics experiments with the machine using photon and lepton beams. The first stage is to study what beams can be produced. 3 references. (UK)

3323 (IPP-9/7) APPARATUS FOR INVESTIGATING THE INFLUENCE OF 5 TO 20 keV ION BEAMS ON METAL TARGETS. Eckstein, W.; Verbeek, H. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jun 1972. 26p. (In German). Dep. NTIS (U. S. Sales Only).

An apparatus for ion bombardment in the energy range of 5 to 20 keV is described. The ion beam produced by a duoplasmatron ion source is cleaned by a magnetic sector field. In the target chamber of 60 cm diameter a pumping speed of 20,000 l/s for H_2 by ion sputter and titanium sublimation pumps is available. The energy and angular distributions of particles backscattered from metal targets can be measured with an electrostatic spherical condenser, which can be moved around the target. The whole apparatus is bakeable up to 250°C. In the target chamber with a 100 μA proton beam 10^{-9} Torr is maintained and with no beam some 10^{-11} Torr is achieved. (auth)

3324 (TRI-72-1) BEAM TRANSPORT SYSTEM FOR THE MEDICAL FACILITY AT TRIUMF. Harrison, Robert W. (TRI-Univ. Meson Facility, Vancouver (British Columbia)). Mar 1972. 140p. Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Victoria Univ., British Columbia.

Preliminary experiments indicate that a beam of negatively charged pions should have a depth-dose pattern that is much more favorable for irradiation of deep-seated malignant tumors than any other type of radiation beam. Consequently, it is proposed that a beam transport system to transmit a pion beam for radiobiological testing of this possibility be built in conjunction with the TRIUMF cyclotron to take advantage of the pions that will be available when the high energy, high intensity proton beam strikes a target in Beam Line I. The beam transport system described should be able to transmit a beam that forms a solid angle of 10 msr at the target and has a momentum spread of ±10% of the central momentum to deliver a 100 rad dose to a volume of 10 cm × 10 cm × 8 cm thick. An achromatic system consisting of two 45 degree bending magnets and five quadrupole focussing magnets has been designed to first order. In addition, the second order aberrations and methods for their correction are discussed; two sextupole magnets should be included in the system to correct some of these geometric and chromatic aberrations. The second order design meets all of the requirements for radiobiology experiments and pre-clinical testing of the potentialities of pions for radiotherapy. (auth)

3325 AUTOMATIC CONTROL SYSTEM FOR A PNEUMATIC TUBE INSTALLATION. Sztaricskai, Tibor (Lajos Kossuth Univ., Debrecen, Hungary). ATOMKI (At. Kut. Intez.) Kozlem.; 13: No. No. 3, 117-20 (Nov 1971). (In Hungarian).

The pneumatic system of pipes, used to transport specimens from the place of activation to a low-background counting room are usually controlled cyclically; the time periods involved depend on the half-life of the product. The pneumatic installation of the 200-kV neutron generator of the Institute is used for several purposes, in addition to activation analysis. A cyclic control system was installed, making it possible to adjust within broad limits the activation, cooling, counting and conveying periods. The radio-frequency ion source is controlled by turning the voltage off and on, thus adjusting the compressed air pressure by means of magnetic valves. The system consists of 4 monostable multivibrator circuits; the individual commands are indicated and checked by means of small light tubes. For added safety, the whole control system was placed in a well insulated and grounded metallic housing. (TTT)

3326 POSSIBLE EXTRACTION OF SLOW MUON FLUX GENERATED NEAR TARGET. Tanabe, Kosai (Yale Univ., New Haven). Saitama Daigaku Kiyo, Shizenkagaku-Hen; 6: 1-27 (Mar 1971).

The behavior of the slow muons generated from the pion decay near the primary target is investigated in great detail. The calculations are based on the recently available pion production cross sections, which include measurements at large production angles and low momenta. The characteristics of the available muon flux are derived by evaluating the intensity distribution in momentum space, muon polarization, and integrated flux intensity for various parameters of an intentionally misaligned channel. Applying the above results, possible methods of transport are investigated. Evaluations of the beam intensity and average polarization are carried out for some simple systems. The result implies that the expected output intensity is comparable to that from an elaborate stopped muon channel of the standard type. (auth)

3327 PRETZEL MAGNET FOR WIDE RANGE SPECTRUM ANALYSIS OF ELECTRON BEAMS UP TO 35 MeV. Rowe, C. H. (Vickers Ltd., Swindon, Eng.). pp 589-605 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

LINEAR ACCELERATORS—beam analyzer for National Research Council electron, pretzel magnet

MAGNETIC ANALYZERS—design of pretzel, for wide range analysis of electron beams up to 35 MeV (W.H.K.)

3328 SUPERCONDUCTING QUADRUPOLE DOUBLET FOR LAMPF SECONDARY BEAM LINES. Hassenzahl, W. V.; Laquer, Henry L.; Novak, Jan K.; Rogers, John D.; Stokes, Robert W. (Los Alamos Scientific Lab., N. Mex.). pp 780-97 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

CLINTON P. ANDERSON MESON PHYSICS FACILITY—beam transport at, superconducting quadrupole doublet for secondary

ELECTROMAGNETIC LENSES—description of superconducting quadrupole doublet, for LAMPF secondary beam lines (W.H.K.)

3329 10 cm APERTURE, 75 cm LONG SUPERCONDUCTING QUADRUPOLE OF CERN. Asner, A. (CERN, Geneva). pp 798-811 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

CERN SYNCHROTRON—beam transport at, superconducting quadrupole lens for

ELECTROMAGNETIC LENSES—description of superconducting quadrupole, for beam transport (W.H.K.)

3330 SUPERCONDUCTING LARGE ACCEPTANCE QUADRUPOLE DOUBLET FOR A SECONDARY BEAM. Aknin, J. P.; Berruyer, A.; Bronca, G.; (and others) (CEN, Saclay, France). pp 822-38 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

ELECTROMAGNETIC LENSES—description of superconducting large acceptance quadrupole doublet, for secondary beams

MESONS (π^+)—focusing of beams of, superconducting quadrupole doublet for

MESONS (π^-) — focusing of beams of, superconducting quadrupole doublet for (W.H.K.)

3331 SUPERCONDUCTING MAGNET FOR THE PRODUCTION OF HIGHLY UNIFORM MAGNETIC FIELDS. Boyes, E.; Court, G. R.; Craven, B.; (and others) (Univ. of Liverpool). pp 977-88 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

MAGNETS — description of superconducting, for polarized proton target

RADIATION TARGETS — magnet for polarized proton, superconducting (W.H.K.)

3332 MAGNETS WITH MICROSECOND RISETIMES PRECEDING MILLISECOND PULSES. Elliott, R. T.; Flower, P. S. (Rutherford High Energy Lab., Chilton, Eng.). pp 1564-93 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

HARWELL SYNCHROTRON (NIMROD) — experimental facilities for, microsecond risetime deflection dipole magnets for delay line separated beams at

MAGNETS — description of microsecond risetime deflection dipole, for separated beams at Nimrod (W.H.K.)

3333 PULSED DIPOLE MAGNET PROVIDING 100 kG ACROSS 40 cm FOR HYPERON EXPERIMENTS. Elliott, R. T. (Rutherford High Energy Lab., Chilton, Eng.). pp 1594-1611 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

HARWELL SYNCHROTRON (NIMROD) — experimental facility for, pulsed dipole deflection magnet for neutral hyperon injection into bubble chamber

RADIATION DETECTORS, BUBBLE CHAMBER — beam injection into, pulsed dipole deflection magnet for neutral hyperon (W.H.K.)

PHYSICS (ASTROPHYSICS AND COSMOLOGY)

3334 ASTRONOMY FROM A SPACE PLATFORM. Proceedings of the Symposium, Philadelphia, Pennsylvania, December 27–28, 1971. Morgenthaler, G. W.; Greyber, H. D. (ed.). Science and Technology Series. Volume 28. A Supplement to Advances in the Astronautical Sciences. Tarzana, Calif.; American Astronautical Society (1972). 412p. $17.50. (CONF-711221). Univelt, Inc., Tarzana, Calif.

The twenty-five papers presented at the conference covered the topics planetary and solar astronomy, stellar and galactic astronomy, new astronomy areas, very large space telescopes, advanced applications and new developments in space astronomical instruments, and strategies for space-based astronomy. (W.D.M.)

Cosmic Radiation

Refer also to abstracts 2552, 3640, 3641, 3644, 3653, 3654, and 3740.

3335 12th INTERNATIONAL CONFERENCE ON COSMIC RAYS, HOBART, AUSTRALIA, AUGUST 16–25, 1971. VOLUME 5. Hobart, Australia; International Union of Pure and Applied Physics (1971). 394p. (CONF-710807-(Vol.5)).

Nineteen papers deal with origin and galactic phenomena, 8 deal with solar particles and photons including radio and magnetic field effects, and 24 deal with solar modulation and geophysical effects on cosmic radiation. All papers are given separate abstracts. (Australia)

For abstracts of individual papers see: 3336–3367, 3402–3407, 3426–3437, and 3489.

3336 ORIGIN OF BACKGROUND RADIATIONS. Prylutskii, O. P.; Rosental, I. L. (Inst. of Cosmic Research, Moscow). pp 1662-6 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol. 5).

Models explaining the spectral features of the x-ray background (break of the spectrum in 40 to 100 keV range) are analyzed. The model of bremsstrahlung origin of the x-ray background has serious difficulties. The models of x-ray background origin (synchrotron model and "dual" model) considered most probable are examined in detail. The x-ray spectrum in the synchrotron model is the continuation of the spectrum of radio background. In the "dual" model, radio background is produced by synchrotron processes and x-ray background is produced by the inverse compton effect of cosmic electrons on relic photons. The most serious difficulty of both models is the explanation of the break in the x-ray background spectrum. (Australia)

3337 ENERGY SPECTRUM OF COSMIC-RAY ELECTRONS FROM 0.5 TO 10 GeV. Swanenburg, B. N.; Burger, J. J.; de Korte, P. A. J. (Kamerlingh Onnes Laboratorium, Leiden). pp 1714-19 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.5).

A cosmic-ray electron detector is flown aboard the OGO-5 satellite. Detailed calibrations of the detector have been carried out in accelerator electron beams (0.5 to 5.5 GeV) and proton beams (0.4 to 21 GeV). The electron spectrum determined from the observations in the solar quiet period April 23, till May 5, 1968 in the energy range 0.5 to 10 GeV is presented. On the basis of the calibrations the systematic uncertainty is estimated to vary from less than ±20% around 1 to 2 GV to less than ±40% at 0.5 and 10 GeV. Comparison with other observations shows a generally consistent picture with those measurements where careful calibrations had been made. The present result supports the conclusion that electrons produced by nuclear collisions in the interstellar gas cannot account for the observed intensity. (auth)

3338 ELECTRON ENERGY SPECTRUM IN GALACTIC COSMIC RAY FLUX IN THE 7 TO 500 GeV ENERGY RANGE. Zatsepin, V. I. (Lebedev Inst. of Physics, Moscow). pp 1720-9 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.5).

New experimental data on primary electron flux in high-energy range obtained during two flights of high-altitude automatic balloons in 1969 and 1970 are presented. The total time of the instrument drift at an altitude of 32 km was about 23 hours. The differential electron energy spectrum at 7 to 500 GeV can be expressed by power law $dn/dE = (95 \pm 12)\ E^{-2.7} \pm 0.0.5\ m^{-2}\ sec^{-1}\ ster^{-1}\ GeV^{-1}$. The difference of the spectrum exponent from that reported earlier is due to the change of criterion for selection of single-charge events. The former selection criterion was valid at energies of 10 to 20 GeV and appeared to be invalid at higher energies because of increased role of back-scattered particles. (auth)

3339 SEARCH FOR ANTIPROTONS IN THE PRIMARY COSMIC RADIATION WITH A MAGNETIC SPECTROMETER. Bogomolov, E. A.; Lubyanaya, N. D.; Romanov V. A. (Ioffe Inst. of Physics and Tech., Leningrad). pp 1730-9 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971)

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.5).

The results of balloon flights of a magnetic spectrometer consisting of a deflecting magnet, a spark chamber system, and a Cherenkov-scintillation counter telescope are presented. The purpose of the experiment was a search for antiprotons in the primary cosmic radiation. The geometric factor of the device was ~1.1 $cm^2 sr$, the deflecting power of the magnet 7.3×10^4 gauss cm, and the angular resolution of the spectrometer 1.3×10^{-3} rad. The telescope selected particles with Lorentz-factors in the range 1.5 to 6.6. The measurements were carried out in summer of 1970. The preliminary value of the antiproton–proton flux ratio in the primary cosmic radiation within the 2.3 to 5.3 GeV range was found to be: $(N_{\bar{p}}/N_p) = (3 \pm 3) \times 10^{-3}$. (auth)

3340 CROSS SECTIONS FOR THE FORMATION AND DESTRUCTION OF COSMIC RAY DEUTERONS AND ^{3}He NUCLEI. Meyer, Jean-Paul (CEN de Saclay, Gif-sur-Yvette, France). pp 1740-5 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.5).

With the aim of interpreting the deuteron and ^{3}He abundances in galactic cosmic radiation, a survey was made of: (i) their production cross sections and reaction kinematics in p–p, p–^{3}He, p–^{4}He and p–(CNO) interactions, with special emphasis on the p–^{4}He reactions, (ii) their destruction cross sections in p–d and p–^{3}He reactions, and (iii) the p–p, p–d, and p–^{4}He elastic scattering cross sections. The experimental data are submitted to critics and the "neutron data" reinterpreted in terms of the mirror proton induced reaction. Whenever reliable observations are lacking, tentative extrapolations are made, based on (i) expected similarities with the nucleon–nucleon cross sections behavior, and (ii) the need for consistency with the total and the inelastic cross sections. (auth)

3341 ENERGY SPECTRUM OF PRIMARY COSMIC RAYS IN THE 10^{11} TO 10^{15} eV ENERGY RANGE ACCORDING TO THE DATA OF PROTON-4 MEASUREMENTS. Grigorov, N. L. (Moscow State Univ.); Gubin, Yu. V.; Rapoport, I. D.; (and others). pp 1746-51 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.5).

The methods of measurements are briefly described. The results of measurements of the spectrum of all particles of primary cosmic rays in the 10^{11} to 10^{15} eV energy range are presented. The results obtained are compared with the data of Proton-1, 2, 3 experiments. (auth)

3342 IRREGULARITY IN THE PRIMARY COSMIC RAY SPECTRUM IN THE 10^{12} eV ENERGY RANGE. Grigorov, N. L. (Moscow State Univ.); Mamontova, N. A.; Rapoport, I. D.; (and others). pp 1752-9 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807–(Vol.5).

Analysis of the integral spectrum of all primary cosmic-ray particles obtained in the Proton-1, 2, 3 experiments shows that the approximation of this spectrum by power law with a single spectrum exponent of 1.7 in the whole studied energy range is

approximate. The power dependence with an exponent of 1.6 and irregularity of the form of a "step" in the 10^{12} eV range agrees much better with the experimental data. This irregularity may be connected with the steepening of proton spectrum in this energy range obtained in the Proton-1, 2, 3 experiments. Such approximation also agrees well with the data on the spectrum of all particles obtained from Proton-4. (auth)

3343 ENERGY SPECTRUM OF COSMIC RAY α-PARTICLES IN 5×10^{10} TO 10^{12} eV/NUCLEON ENERGY RANGE. Grigorov, N. L. (Moscow State Univ.); Rapoport, I. D.; Savenko, I. A.; Nesterov, V. E.; Prokhin, V. L. pp 1760-8 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

The results of measurements of the energy spectrum of primary cosmic-ray α particles at 5×10^{10} to 10^{12} eV/N from Proton-3 satellite are presented. At 5×10^{10} to 10^{11} eV/N the spectra of α particles and protons are similar, the only difference is in intensity. The ratio of α-particle to proton fluxes of the same energies is 0.56 ± 0.1. (auth)

3344 INVESTIGATION OF THE COMPOSITION OF PRIMARY COSMIC RADIATION AT $>10^{13}$ eV. Sokolovskii, V. I. (Lebedev Inst. of Physics, Moscow). pp 1769-81 of 12th International Conference on Cosmic Rays. Vol. 5 Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

A method permitting the investigation of primary composition by analyzing the structure of the hadronic component of cosmic radiation in the atmosphere is proposed. This method involves separating the events, caused by primary protons, from events, caused by heavier nuclei, and has a better resolution of the atomic weight of primary particles, than other methods of investigation of primary composition at high energies. The essential dignity of the proposed method is the possibility of additional experimental checks and the independence of those checks from the parameters of nuclear-cascade process in the atmosphere. The experimental results concerning primary composition at ~(10^{13} to 10^{14}) eV, obtained in the Tjan-Shan complex installation, are given. It is concluded, that the primary composition in this energy range, is similar to that at ~2.5 GeV/N. (auth)

3345 COMPOSITION OF HEAVY COSMIC RAY NUCLEI OF $Z > 23$. Kashkarov, L. L.; Genaeva, L. I.; Lavrukhina, A. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). pp 1782-91 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

A detailed study of the composition of cosmic-ray nuclei of the $23 \lesssim Z \lesssim 50$ region was made using fossil charged-particle tracks, identified in olivine minerals from the meteorite Ilimaes. Using the results of experiments and theoretical calculations for relativistic nuclei with $Z > 30$ and of calibration experiments performed for nuclei with charge up to $Z \cong 28$, the charge composition of primary cosmic-ray nuclei which correspond to the observed tracks was determined. The ratio of intensities of VVH—($Z > 30$) to the VH—group ($20 < Z < 30$) of cosmic rays is discussed on the basis of 350 tracks observed at a depth above 15 cm from the preatmospheric surface of the meteorite. For various nuclei charge of the VVH—group the following values of ratio VVH/VH were obtained: $(0.5 \text{ to } 0.9) \times 10^{-4}$ for $30 < Z < 40$ and $\gtrsim 1.10^{-5}$ for $Z > 40$. The greatest length of tracks which was observed and measured in more than 100 individual olivine crystals equals 200μ which corresponds to nuclear charge about 50. The depth of sample location was determined with aid of the measured gradient of VH-nuclei track density. In this way the correlation of the observed VH-track density and theoretical data gives the preablation size of the meteorite Ilimaes the radius of which is $R_0 \cong (27 \pm 3)$ cm if its cosmic-ray exposure age is assumed to be 50×10^6 years and its initial shape spheroidal. On this basis the energy range of detectable heavy cosmic rays was carried out. The angular distribution of VH- and VVH-tracks was strongly anisotropic and agreed with the expected distribution proceeding from the assumption that VH- and VVH-nuclei are the main source of these tracks. (auth)

3346 HIGH RESOLUTION STUDIES OF COSMIC RAYS WITH $Z > 30$. Kobetich, E. J. (Univ. of California, Berkeley); Price, P. B.; Shirk, E. K.; (and others) pp 1792-6 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

In a 2 g/cm^2 stack containing Lexan, cellulose triacetate, emulsion, and Cherenkov film detectors that had been exposed for 8000 m^{2}h in a balloon launched from Minneapolis, tracks of ~200 nuclei with $Z > 30$ were studied in 80% of the exposed area. These particles either stopped in the bottom 1 g/cm^2 or penetrated the entire stack. The velocity and charge of these particles were determined from a combined study of etching rates in the plastic and photodensitometry in the emulsion. Sixty-six tracks were analyzed in the plastic. Preliminary results indicated that two transuranic nuclei were found, one stopping in the stack and the other penetrating the stack with no measurable change in ionization. The latter, if minimum-ionizing, would have a charge of approximately 114. Twelve other nuclei with $Z > 70$, eight with $45 < Z < 70$, and 44 with $30 < Z < 45$ were detected. (auth)

3347 NON-RANDOM SUB-DIURNAL VARIATIONS IN SIDEREAL MUON COINCIDENCE TIME SERIES. Kisselbach, V. J. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). pp 1797-1800 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

A synchronization and superposition analysis was carried out on cosmic-ray muon data recorded in 0.1 h rectascension intervals with the cosmic-ray muon monitor at Lindau. A total of 114 days was subjected to filter analysis. The analysis shows that the transmission functions of windows up to at least the W_6 component display nonrandomness for 95% and 5% confidence percentiles when subjected to a statistical runs test. In a conventional amplitude determination analysis, amplitude of the order of 0.1% are shown a) to display phase constancy within the experimental error; and b) not to decrease inversely with the one-half power of the number employed (i.e., not to obey the "$1/\sqrt{n}$ law"). Possible causes usually adduced to explain such variations, viz., random statistical fluctuations, data curvature, spurious sideband generation effects, etc., are discussed. It is concluded that these traditionally adduced "sources" of sidereal variations are not of sufficient weight to account for all of the variability observed and that hence the presence of several apparent or true sidereal effects known from the literature is indicated. (auth)

3348 COSMIC PARTICLES OF SUPERHIGH ENERGY. Prilutskii, O. P.; Rosental, I. L. (Inst. of Cosmic Research, Moscow). pp 1801-4 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Presence of electromagnetic fields was required for any model of very high-energy cosmic-ray acceleration. Rapid increase of synchrotron energy losses restricts maximum energy in any known model of acceleration. Direct pair production in strong electromagnetic fields also restricts the acceleration of high-energy hadrons. Analysis shows that in the Galaxy there are no sources of 10^{19}- to 10^{20}-eV particles. Metagalactic origin of superhigh-energy particles conflicts with known difficulties caused by the presence of relic radiation. There are two alternative ways out of the situation: 1) superhigh-energy particles are very heavy nuclei; they do not reach the threshold of pion production on relic radiation; 2) a more probable assumption: very high-energy EAS's are caused by neutrinos. (auth)

3349 LONG-TERM SOLAR MODULATION OF COSMIC-RAY ELECTRONS WITH ENERGIES ABOVE 0.5 GeV. Burger, J. J.; Swanenburg, B. N. (Kamerlingh Onnes Laboratorium, Leiden). pp 1858-63 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

The variation of the cosmic-ray electron intensity measured above 0.5 GeV aboard the OGO-V satellite between the periods April 23-May 5, 1968 and June 13-July 8, 1969 is reported and discussed. It is shown that the interplanetary cosmic-ray diffusion coefficient cannot be a separable function of rigidity and heliocentric distance. (auth)

3350 MODULATION REGION OF GALACTIC COSMIC RAYS. Lavrukhina, A. K. (Inst. of Geochemistry and Analytical Chemistry, Moscow). pp 1864-72 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

It has been found that the upper boundary of the region of galactic cosmic-ray modulation lies at solar distances of ≤ 2 AU. A latitude variation of that boundary is absent. In many

experiments on cosmic rockets and ball probes carried out during the 19th and 20th cycles of solar activity attempts were made to determine temporary variations of the galactic cosmic-ray flux. All known data allow to correctly understand the physics of processes which lead to galactic cosmic-ray modulation. However, many details of the modulation phenomenon are not yet clear. Thus the exact dimensions of the region of the galactic cosmic-ray modulation are not known. The values obtained by various scientists are quite different: from 2 to 5 to 100 AU/1-5. These estimations are based on the account of electromagnetic condition delay in the interplanetary space with respect to solar processes which cause this delay. Actually the delay degree of the changes of galactic cosmic-ray flux is conditioned by the dimensions of the modulation region or more exactly by the time of the solar wind motion which cause the galactic cosmic-ray modulation from the Sun to the boundary with galactic magnetic fields. Various scientists used different parameters of solar activity for the determination of the solar-wind power and therefore obtained various values of the modulation region dimension. However it is not clear, which parameters really characterize the solar wind power. Besides the effective heliolatitude of solar activity decreases during solar cycles, which leads to greater difficulties when working out quantitative models of the modulation phenomenon. (auth)

3351 SAMPLES FROM A SYSTEMATIC STUDY OF THE COSMIC RAY AXIAL ANISOTROPY 1965 TO 1968. Lindgren, S. T.; Larfors, O.; Sporre, B.; Tolba, M. F. (Uppsala Univ.). pp 1873-8 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

The axial component of observed cosmic-ray anisotropies was investigated by means of hourly intensity differences between north- and south-looking stations (Alert, Thule, McMurdo), 1965-1968. Most of the anisotropic events are associated with cosmic-ray decreases. A few events extend over 5 to 7 days, most events last only a day or two. Some events show quasi-periodic fluctuations in the 10 to 20 hr range. Many events show remarkable similarities with simultaneous Kp variations. Seemingly unexplainable cases of axial anisotropy have also been observed. (auth)

3352 SEMI-DIURNAL ANISOTROPY OF COSMIC RADIATION. Kargathra, L. V.; Sarabhai, V. A. (Physical Research Lab., Ahmedabad, India). pp 1879-84 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

The semi-diurnal anisotropy of galactic cosmic rays was studied using hourly differences of cosmic-ray intensities, recorded by west and east pointing meson telescopes at Ahmedabad. The difference between the corrections for the geomagnetic bending to be applied to the times of maxima of the semi-diurnal variations in the two directions, $|\tau_{2W} - \tau_{2E}| \approx 5$ to 6 hours is almost independent of β the exponent of the energy spectrum of variation of the anisotropy in the range -1.2 to 1.0. This circumstance provides a powerful tool to study on a day to day basis the semi-diurnal component unaffected by meteorological variations. The ratio of relative amplitudes (α_{w2}/α_{E2}) which varies from -1.05 to 0.85 for $\beta = 1.2$ to 1.0, allows one to estimate the contribution to the semi-diurnal variation not related to an anisotropy of the galactic intensity. (auth)

3353 PERIODIC COMPONENT OF SUDDEN CHANGES IN COSMIC RAY INTENSITY. Nash, A. A. (Univ. of Melbourne). pp 1885-90 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

A search was conducted for a periodic component of sudden changes in the pressure corrected neutron indices of NM-64 monitors. A sudden change was defined as a 0.5% change between consecutive hourly indices, increases and decreases being treated separately. The results of the diurnal frequency distributions of the times of sudden events are in general agreement with those of previous investigators. The results of averaged epoch profiles of cosmic ray intensity at the time of sudden changes show enhanced diurnal structures. Power spectra of the time distribution of the changes display diurnal peaks. It appears that the diurnal variation in cosmic-ray intensity is the principal contributor to this periodic component because a variation in hourly rate of change is inherent in a variation of intensity. There is some evidence for a secondary periodic component, possible sources could be invalid pressure corrections or the diurnal variation in cosmic-ray cutoff. (auth)

3354 SHORT-TERM VARIATIONS OF THE COSMIC-RAY PROTON AND ELECTRON INTENSITIES IN 1968 AND 1969. Baixeras-Aiguabella, C. (Kamerlingh Onnes Laboratorium, Leiden). pp 1891-6 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

A cosmic-ray detector aboard OGO-V monitors the differential electron energy spectrum between 0.5 to 10 GeV and the integral intensities of protons and α particles above 400 MeV/N kinetic energy. Several Forbush decreases observed in 1968 and 1969 are compared with the corresponding Sulphur Mt. neutron monitor counting rate changes. It is concluded that the intensity variations ~1 GV show a smaller rigidity dependence for Forbush decreases than for the long-term variations. (auth)

3355 GALACTIC COSMIC RAY CURRENT DURING OCTOBER-NOVEMBER 1968. Altuchov, A. M.; Krymskii, G. F.; Kuzmin, A. I.; Skripin, G. V.; Transkii, I. A. (Inst. of Cosmophysical Research and Aeronomy, Yakutsk, USSR). pp 1897-1909 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

The behavior of a current of galactic cosmic rays during October-November 1968 is considered. It is shown that the current reflects the influence of solar activity. Current structures observed from September to December 1968 are given. They are compared with expected structures caused by the Earth's passage through the rapid stationary flux boundary and a shock-wave front propagated from the Sun. (auth)

3356 RECURRENT EFFECTS IN THE GALACTIC COSMIC RAY INTENSITY MODULATION DURING THE LAST SOLAR CYCLE OF ACTIVITY. Sigvard Ruthberg, K. S. (Uppsala Univ.). pp 1910-15 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

Particular attention is given to the 27-day component of the galactic cosmic-ray intensity modulation and its relations to the solar activity. Daily values of the cosmic-ray intensity (Deep River neutron Monitor), geomagnetic index of activity Ap, and Zürich relative sunspot numbers were analyzed by numerical power spectrum and filter (Complex demodulation) techniques through the years 1958-1969. Relations between pairs of those parameters were studied through cross correlation. The results confirm earlier observations of marked recurrent correlations between the solar activity and the galactic cosmic-ray intensity modulation in the decreasing and the increasing phase of the solar cycle of activity. (auth)

3357 CHARACTERISTIC FEATURES OF THE COUPLING OF THE COSMIC RAY QUASI-PERIODIC VARIATIONS WITH SOLAR ACTIVITY. Alania, M. V. (Inst. of Geophysics, Tbilisi, USSR). pp 1916-24 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

It is shown that the delay time of the processes in cosmic-rays relative to solar activity for the quasi-periodic variations (with a period of t = 11-27 days, and t = 35 to 45 days) is 25 to 35 days and is 2 to 3 times smaller than the delay time in the annual and semiannual cosmic-ray variations. The interpretation of the results is given on the basis of the dynamical processes theory in the interplanetary space. (auth)

3358 27-DAY VARIATIONS OF COSMIC RAY ANISOTROPY BY THE NEUTRON COMPONENT DATA FOR THE I.G.Y. PERIOD. Shatashvili, L. Kh. (Georgian Academy of Sciences, Tbilisi, USSR); Pankratov, A. K. pp 1925-35 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

The diurnal variation of cosmic ray anisotropy in connection with solar rotation was studied. Cosmic-ray anisotropy was studied using simultaneous data of the neutron component intensity according to the observation of six stations with close cutoff rigidities of the initial cosmic rays and located at different longitudes for the period of the first 8 months of I.G.Y. (auth)

3359 ISOTROPIC AND ANISOTROPIC FLUX VARIATIONS WITH 12 TO 34-DAY QUASI-PERIODS. Chumbalova, R. A.; Gonchar, G. A.; Kolomeets, E. V.; Musabaev, M. A.; Zusmanovich, A. G. (Kazakh State Univ., Alma-Ata, USSR). pp 1936-46 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

During the period 1959-1969, the analysis of aperiodic intensity variation of the cosmic-ray neutron component was carried out. Cosmic-ray intensity variation with 12-34- day quasi-periods was found. It is shown that these are the periods of change of the anisotropic flux of cosmic-ray intensity. Energy spectra for isotropic and anisotropic fluxes of the variations were obtained. The expected cosmic-ray intensity variations were calculated in terms of the correlation between cosmic-ray intensity and solar activity. It is shown that the time variation of activity of the Sun accounts for the obtained variation. It is also shown that the cosmic-ray anisotropy variation is correlated with the solar-wind velocity and the interplanetary magnetic field direction. (auth)

3360 COSMIC RAY INTENSITY DURING THE INITIAL PHASE OF THE 20th SOLAR ACTIVITY CYCLE DECREASE. Vernov, S. N.; Lyubimov, G. P. (Moscow State Univ.). pp 1947-58 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Data on the intensity of solar and galactic low-energy cosmic rays obtained from Venus-7 space Probe and Lunokhod-I moving lunar laboratory are presented. The change in the moving intensity level of protons with energies of 1 to 5 MeV, >30 MeV, and >1 GeV (neutron monitor) for the period from August 1970 to April 1971 are analyzed. An abrupt jump in solar activity and >30 MeV galactic cosmic-ray intensity was noted in the beginning of 1971. The connection of the observed solar and galactic cosmic-ray intensity with solar activity variations is discussed. The 11-year dependence of low-energy cosmic-ray intensity since 1959 is analyzed. (auth)

3361 POWER SPECTRUM OF THE GALACTIC COSMIC RAY INTENSITY. Martinic, N. J. (Uppsala Univ.). pp 1959-63 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Power spectra of fluctuations of the cosmic-ray intensity recorded by neutron monitors, covering the range 1.1×10^{-7} to 1.3×10^{-4} cps were calculated for different periods from 1963 to 1968. The frequency dependence of the power was found to vary between $f^{-\frac{1}{2}}$ and f^{-2}. These dependences suggest a "relationship" with discontinuities in the density of the cosmic-ray gas in the interplanetary cavity. Also shown are samples of the power spectrum tensor of the interplanetary magnetic field as recorded by IMP-3 during Oct. 1966. They show dependencies of the form $f^{-\frac{1}{2}}$ to f^{-1} in the range 1.5×10^{-5} to 1.5×10^{-3} cps. The form of these spectra and the anisotropy of discontinuities of the interplanetary magnetic field are discussed. (auth)

3362 ENERGY SPECTRUM OF GALACTIC COSMIC RAYS OUT OF THE MODULATION REGION. Kolomeetz, E. V.; Zusmanovich, A. G. (Kazakh State Univ., Alma-Ata, USSR). pp 1964-73 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

The modulation coefficient in different periods of a solar activity and the spectrum of galactic cosmic rays out of the modulation region were obtained from the data on cosmic-ray spectra, registered out of the Earth's atmosphere. Spectra of protons, helium and nucleons with $Z > 2$ in the energy range ~0.1 to 20 BeV/N was studied. At the solar activity minimum in 1965 the modulation coefficient $K = \ln(n_c/n)$ had a value 0.3 for the 1BV rigidity of the primary particles. It was found that the unmodulated spectrum of galactic cosmic rays was given by an exponential function then the exponent of spectrum decreased with decreasing particle energy. The data for the most probable form of the spectra of protons and nucleons of galactic cosmic rays out of the modulation region are shown. It is noted, that a decrease of the spectrum exponent in the low-energy region takes place when any reasonable suggestions about the dependence of the modulation coefficient K on the rigidity are considered. (auth)

3363 ANNUAL VARIATIONS OF COSMIC RAY INTENSITY. Kolomeetz, E. V.; Shahova, Yu. A. (Kazakh State Univ., Alma-Ata, USSR). pp 1974-83 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Using the neutron monitor data for the period from 1958 to 1969, the annual variations of cosmic-ray intensity were investigated. Their amplitude and phase characteristics were determined and it is shown that amplitude of annual variations depends on cutoff rigidity. The energy spectrum of annual variation was calculated for the different period of solar activity. The contribution of different sources to the annual variation of cosmic rays intensity is investigated. Using the experimental data, the radial and cross gradients of cosmic rays were calculated for the different periods of solar activity. (auth)

3364 STUDY OF SOLAR WIND ACCORDING TO THE DATA ON 11-YEAR COSMIC RAY MODULATION. Charakhchyan, A. N.; Charakhchyan, T. N. (Lebedev Inst. of Physics, Moscow). pp 1984-91 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol.5).

The problems connected with the spatial dependence of magnetic fields, H, in the solar wind and the boundary r_0, of the field propagation in interplanetary space are discussed. The value H decreases as $H \sim 1/D$ where D is the distance from the Sun. The volume of magnetic fields in the solar wind, V, increases approximately as D^2 because of their expansions. The data on the cosmic-ray intensity relaxation time show that the deceleration of these fields in the space takes places mainly in the region $r_0 \approx 10$ to 20 AU where the values H are almost the same as those of magnetic fields in the interstellar space, $H \sim 3.10^{-6}$ g. (auth)

3365 REGISTRATION OF ADDITIONAL FLUX OF ENERGETIC ELECTRONS IN THE UPPER LAYER OF THE ATMOSPHERE. Galper, A. M.; Dmitrenko, V. V.; Kirillov-Ugryumov, V. G.; (and others) (Engineering Physical Inst., Moscow). pp 2021-9 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Electron fluxes in the 100- to 1500-MeV energy interval were measured during high-altitude balloon flights in the upper layers of the atmosphere and in areas with the geomagnetic latitude 46°N, 49°N, and 58°N. At depths less than 50 g/cm^2 of the residual atmosphere, anomalously large fluxes of electrons, in the above energy interval, were recorded on the days when magnetic substorms were observed ($\Sigma kp = 18$ to 23, $\Delta\Sigma kp = 10$ to 13). An additional electron flux occurring in a substorm amounted to ~0.1 (cm^2 sec ster)$^{-1}$ on the boundary of the atmosphere. It was characterized by a power-law spectrum with the index of 2.2 ± 0.3 and its intensity decreased to a half per day. There is evidence confirming that the additional flux of high-energy electrons is connected with auroral phenomena. The sources of the flux and its effect on cosmic primary electrons are discussed. (auth)

3366 LATITUDES-LONGITUDE STRATOSPHERIC MEASUREMENTS OF COSMIC RAY INTENSITY. Charakhchyan, A. N.; Svirzhevskaya, A. K.; Stozhkov, Yu. I.; Charakhchaan, T. N.; Kuzmin, I. A. (Lebedev Inst. of Physics, Moscow). pp 2043-52 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

The problems connected with planetary distribution of cosmic-ray intensity in the stratosphere at altitudes of 10 to 30 km are considered. The comparison of experimental data on cosmic-ray intensity in the stratosphere obtained at various latitudes and longitudes with the calculations of the cutoff rigidity, P_c, using various theoretical models has shown that the values of P_c are determined most accurately by the trajectory method. However, in the magnetic anomaly regions there is some discrepancy between the calculation and experimental data. (auth)

3367 STUDY OF AN ATMOSPHERIC ANOMALY NEAR THE ANDES MOUNTAINS IN THE CALCULATION OF THE BAROMETRIC COEFFICIENT OF THE SECONDARY COSMIC RAY FLUX. Alvial, G.; Lara, H.; Mezzetti, G. (Univ. Chile, Santiago de Chile). pp 2053-8 of 12th International Conference

on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

An analysis is reported of the determination of a positive barometric coefficient for the flux measured at Los Cerrillos, β_C, and for an atmospheric layer comprised between 949.4 mbar and near 598 mbar; a negative coefficient, β_I, for pressures above 598 mbar and referred to the same station; and a negative temperature coefficient ($K_C + \alpha_n$), for the flux measured at Los Cerrillos. This last coefficient is composed of a surface temperature coefficient K_C and a temperature effect of the plastic counters, α_n. The value obtained for α_n by regressional analysis agreed very well with a direct determination. (auth)

3368 TD-1A: EUROPE'S LARGEST AND MOST ADVANCED SATELLITE. Ind. At. Spatiales; 16: No. 3, 81-7(May 1972). (In French and English).

ESRO's TD-1A satellite launched last March carries a payload of seven experiments from six European countries aimed at stellar ultraviolet spectroscopy and solar and cosmic ray radiation research. It is Europe's first astronomical satellite. Orbital and attitude characteristics were chosen so that the sky-pointing experiments would scan the complete celestial sphere within six months. The experiments and satellite subsystems are described. (France)

3369 INTERACTIONS OF COSMIC RAYS WITH HYDROMAGNETIC WAVES IN THE GALAXY. Cesarsky, Catherine Jeanne. Cambridge, Mass.; Harvard Univ. (1972). 122p. University Microfilms Order No. 72-12,716.

Thesis.

The possibility that ultrarelativistic cosmic rays are confined to the galactic disk as a result of their interactions with hydromagnetic waves is examined. Cosmic rays themselves, when they stream at velocities in excess of the Alfvèn velocity in the medium, generate waves; the waves are damped by the collisions between the charged and neutral particles in the interstellar medium. Turbulent gas motions in the Galaxy are a possible source of long hydromagnetic waves, with wavelengths of the order of a few parsecs. The diffusion of cosmic rays in the presence of given spectrum of hydromagnetic waves is parameterized by their mean free path, λ. Because of charged-neutral collision damping the power needed to sustain a spectrum of waves that extends to the shortest wavelengths of interest in an intercloud medium with currently accepted properties ($n_H = 0.2$ cm^{-3}, $n_e = 0.02$ cm^{-3}, T = 1000°K), is unacceptably high. A model for the propagation of cosmic rays in the Galaxy is proposed, in which cosmic rays traverse the gas disk, of thickness 300 pc, at large speeds, but diffuse slowly in 2 slabs of hot and diffuse gas, 200 pc thick, at each side of the gas disk. It is shown that the predictions of this model agree with the available observations. (Diss. Abstr. Int., B)

3370 EFFECTS OF PROTON-ATMOSPHERIC-NUCLEI INTERACTION PROCESSES ON PREDICTED MUON INTENSITIES. Magnuson, C. E.; Wayland, J. R.; Green, P. J. (Texas A and M Univ., College Station). Phys. Rev., D; 6: No. 9, 2431-6(1 Nov 1972).

In numerous calculations of the muon intensity deep in the atmosphere, the details of the interactions which produce pions and kaons have been avoided by assuming a production spectrum proportional to $E^{-\alpha}$, where α is a constant. In contrast to this approach, a realistic form is used for the primary cosmic-ray spectrum in which the spectral index varies with energy, and the cosmic-ray proton-atmospheric-nuclei interactions are described using a statistical model for pion and kaon particle production. The resulting relative muon intensities at sea level are calculated and are found to fall off more rapidly with momentum than intensities predicted by previous calculations. The muon charge ratio as a function of momentum (conveniently normalized to agree with experiment at low energies) is found to be sensitive to the spectral character of the primary cosmic-ray spectrum. Similar effects were found for muon intensities at large zenith angles resulting in no significant effects on predicted zenithal enhancements. (auth)

3371 OBSERVATION OF LOW-CHARGE LOW-ENERGY GEOMAGNETICALLY FORBIDDEN PARTICLES. Blanford, G. E. Jr.; Friedlander, Michael; Klarmann, Joseph; (and others) (Washington Univ., St. Louis). J. Geophys. Res.; 77: No. 31, 6037-41(1 Nov 1972).

Evidence for the existence of a hitherto unrecognized flux of nuclei of a charge of $6 \lesssim Z \lesssim 26$ and kinetic energies of <150 MeV/nucleon at 4 g/cm^2 residual atmosphere over Texas (41°N geomagnetic) is presented. The flux observed at the balloon-borne detector is $(2.3 \pm 0.5) \times 10^{-5}$ particle/m^2 ster sec, which is comparable in intensity to the flux of primary cosmic-ray nuclei having Z > 35. This flux is in qualitative agreement with estimates of the flux expected from re-entrant albedo, produced by interactions of primary Fe group nuclei in the atmosphere. The implications of these findings for observations of the flux of very heavy primary cosmic-ray nuclei are considered. (auth)

3372 RELATION BETWEEN SOLAR AND PLANETARY NEON IN CARBONACEOUS CHONDRITES. Herzog, G. F. (Univ. of Chicago). J. Geophys. Res.; 77: No. 31, 6219-25 (1 Nov 1972).

The possibility that an early charged-particle irradiation converted solar Ne trapped in primitive silicaceous material to planetary Ne was discussed. The reactions ^{24}Mg (p,α) and ^{25}Mg (p,α) seemed most promising, but calculations of production rate ratios place severe restrictions on the energy spectrum of bombarding protons or on the cross section of the ^{24}Mg (p,α) reaction. An alternative transformation process, mass fractionation, cannot give planetary gas either. It appears that a combination of processes that includes the production of ^{22}Ne by a proton irradiation may be needed to account for planetary Ne. The multicomponent hypothesis offers another possible explanation. (auth)

3373 MEASUREMENT OF THE ATMOSPHERIC NEUTRON FLUX IN THE ENERGY RANGE 50 < E < 350 MeV. Eyles, C. J.; Linney, A. D.; Rochester, G. K. (Imperial Coll. of Science and Tech., London). Planet. Space Sci.; 20: No. 11, 1915-22(Nov 1972).

A series of telescopes having approximately a 30° half opening angle and responding to neutrons in the energy range 50 to 350 MeV has been flown to the top of the atmosphere on balloons released from an equatorial launching site at Kampala, Uganda, between 1967 and 1970. The downward moving neutron flux has been measured as a function of altitude, and is compared with other results in similar energy ranges. The neutron albedo at a residual atmospheric depth of 3 mb has been measured to be 0.24 ± 0.10 neutrons m^{-2} sec^{-1} MeV^{-1} at approximately 140 MeV. This value is considerably higher than previously accepted theoretical predictions. The implications of this higher value are discussed in relation to the population of the Earth's inner radiation belt by neutron decay protons. (auth)

Stars

Refer also to abstracts 3410, 3454, and 3457.

3374 (AD-740678) CALIBRATION OF THE HERTZSPRUNG-RUSSELL DIAGRAM IN TERMS OF AGE AND MASS FOR MAIN-SEQUENCE B AND A STARS. Kelsall, T.; Stroemgren, B. (Institute for Advanced Study, Princeton, N. J. National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). 1972. Contract Nonr-1853(63). 32p. NTIS.

The calibration of the Hertzsprung-Russell diagram in terms of age and mass for main-sequence B and A stars was derived from the results of the Kelsall evolutionary model sequence calculations. (GRA)

3375 (AD-740680) PROBLEMS OF STAR FORMATION. Mestel, L. (Institute for Advanced Study, Princeton, N. J.). 1972. Contract Nonr-1858(33). 63p. NTIS.

The lectures deal mainly with the condensation of self-gravitating masses of gas from cosmic clouds, with special attention to difficulties due to angular momentum and a magnetic field. Emphasis is laid on the dynamical problems of the early stages, before opacity becomes important. (auth) (GRA)

3376 SPECTRUM OF THE SUPERGIANT ϵ ORIONIS (B0 Ia). I. IDENTIFICATIONS, EQUIVALENT-WIDTHS, LINE PROFILES. Lamers, H. J. (Astronomical Inst., Utrecht). Astron. Astrophys., Suppl. Ser.; 7: No. 1, 113-32(Sep 1972).

The visual spectrum of the supergiant star ϵ Ori (B0 Ia, HD 37128) is described. A list of observed lines, their identification, and blend-free equivalent-width is presented. The two unidentified emission lines at λ4486 and λ4504 are found to be present. The profiles of a number of important spectral lines are given. (auth)

3377 PHOTOMETRIC STUDIES OF UV CETI. Jarrett, A. H.; Eksteen, J. P. (Boyden Observatory, Bloemfontein, S. Afr.). Astron. Astrophys., Suppl. Ser.; 7: No. 1, 103-12(Sep 1972).

Further flare observations of UV Ceti confirmed the profiles obtained from earlier observations at Boyden Observatory. (auth)

3378 FIVE-COLOUR PHOTOMETRY OF THE ECLIPSING BINARY HO TELESCOPII. Spoelstra, T. A. Th.; van Houten, C. J. (Leiden Observatory). Astron. Astrophys., Suppl. Ser.; 7: No. 1, 83-102(Sep 1972).

528 five-color photoelectric measurements are presented of the

eclipsing binary HO Telescopii, observed during 13 nights in August and September 1965 at the Leiden Southern Station. Four epochs of the minimum were used to derive a new period of 1.613409 days. Normal points are given in a table at the end of the paper. The light-curve is quite normal; primary and secondary minimum are about equally deep in all five colors. (auth)

3379 BARIUM AND R TYPE STARS. Eggen, O. J. (Australian National Univ., Canberra). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 403-27(1972).

(UBVRI) photometry of R and barium stars (including CH stars) is discussed in connection with the red-giant branch of the old disk population (Wolf 630 Group and M67 cluster). Luminosity calibrations are obtained from membership in moving groups, clusters or wide binaries and from Olin Wilson's observations of H and K emission widths. Barium and R stars may only be present among objects of two or three solar masses or less. It is concluded that old disk population N stars represent the short, core-helium ignition stage of 1 to 2 solar mass stars which then either pass to the M variable stage before becoming asymptotic branch (barium) stars, or vice versa. (auth)

3380 ELECTRONOGRAPHIC PHOTOMETRY OF STAR CLUSTERS IN THE MAGELLANIC CLOUDS. 4. THE COLOUR-MAGNITUDE DIAGRAM OF NGC 419. Walker, M. F. (Univ. of California, Santa Cruz). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 379-88(1972).

Electronographic magnitudes and colors of 146 stars in and near the cluster NGC 419 in the Small Magellanic Cloud have been measured to V = 20.9 on electrographs taken with a Spectracon image-converter attached to the f/7.5 focus of the Cerro Tololo 60-in reflector. Comparison with the photographic photometry of Arp (Astr. J., 63: 273 (1958)) indicates that at distances of $\tau > 110''$ from the center of the cluster, Arp's photometric calibration is quite good over the range $15.5 \leq B, V \leq 20.1$. However, for $\tau \leq 110''$ the photographic measures are affected by background light from the faint, unresolved members of the cluster. The upper portion of the color-magnitude diagram of NGC 419 consists of a red-giant branch which extends from V = 15.9 and B – V = +2.0 to V = 19.8 and B – V = +0.7 and resembles that in Kron 3. However, fainter than V ≃ 19.8 the diagram is confused by the presence in the field of many early-type main-sequence stars belonging to the main body of the Small Magellanic Cloud. Consequently, it is not clear whether NGC 419 is: (1) a cluster like Kron 3 but in which there is a gap in the giant-branch between about V = 19.8 and V = 20.3, or (2) is a cluster more like NGC 2209 with a red-giant branch, a small Hertzsprung gap, and an evolved main-sequence whose upper end appears at about V = 20.2 and B – V = +0.25. One extremely red star was measured which is probably a carbon star belonging to the general population of the Small Magellanic Cloud. (auth)

3381 COMMENT ON THE USE OF THE DISPLACEMENT POTENTIAL IN PULSATIONAL ANALYSIS. Vaughan, G. J. (Univ. of Sussex, Brighton, Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 375-7(1972).

A mathematical error in Rosseland's "Pulsational Theory of Variable Stars" (Rosseland, 1949) is pointed out and a cautionary word on the use of the displacement potential technique is given. (auth)

3382 SPECTROSCOPIC STUDY OF THE BLUE GLOBULAR CLUSTERS IN THE LARGE MAGELLANIC CLOUD. Andrews, P. J.; Evans, T. L. (Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 445-52(1972).

Spectra were obtained for 15 blue globular clusters in the LMC. Spectral types on an arbitrary system correlated well with Johnson's reddening free parameter Q. The velocities followed the same rotation curve as that defined by the objects of extreme Population I. The velocity dispersion was slightly larger, with weak evidence for an increase with age within the sample. (auth)

3383 OBSERVATIONS OF RAPID BLUE VARIABLES. 12. UX URSAE MAJORIS. Warner, B.; Nather, R. E. (Univ. of Texas, Austin). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 429-44(1972).

Photoelectric photometry of the nova-like variable UX UMa with time resolution of 1 to 5 s is reported. Times of mid-eclipse, compared with a previous ephemeris, indicate that the mean period of UX UMa may be shorter by $\sim 7 \times 10^{-8}$ than previously believed. Two observing runs made in January 1971 show a very clear periodicity in the light curve of 29.44 and 28.92 s respectively. The mean light curves of these variations are sinusoidal with a semi-amplitude of 0.002 mag. In one of these runs, the periodicity is present before eclipse, but not afterwards. This behavior is similar to that of the DA absorption spectrum of the primary in UX UMa, and indicates that the primary is the source of the pulsations. Several observing runs made two months later show no sign of the 29-s periodicity. A discussion is given of known periodicities in other white dwarfs. (auth)

3384 APPLICATION OF SYNTHETIC SPECTRA TO COLOUR SYSTEM TRANSFORMATIONS. 1. THE RGU AND UBV SYSTEMS. Bell, R. A. (Univ. of Maryland, College Park). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 349-55(1972).

Synthetic spectra, computed for F and G dwarf stars, have been used to compute theoretical UBV and RGU colors. These colors have been used to obtain the transformation equations between the two systems. These equations have been checked against UBV and RGU colors computed for hotter stellar models. The effects of metal abundance and gravity on the theoretical colors of the cooler stars have been examined. It is shown that the location of a star in the U–G, G–R diagram is marginally more sensitive to changes in abundance or gravity than is the case for the U–B, B–V diagram. The effect of reddening on the colors is examined. (auth)

3385 APPLICATION OF SYNTHETIC SPECTRA TO COLOUR SYSTEM TRANSFORMATIONS. 2. THE PHOTOGRAPHIC AND PHOTOELECTRIC UBV SYSTEMS. Bell, R. A. (Univ. of Maryland, College Park). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 357-60(1972).

Synthetic spectra and the photoelectric and various photographic UBV sensitivity functions are used to compute theoretical colors for F and G dwarfs. Similar calculations are made for hotter stars. It is shown that photographic V magnitudes obtained using 103a-G emulsion and a GG 11 filter will be in better agreement with photoelectric V magnitudes than is the case when the 103a-D emulsion is used. The photographic and photoelectric U and B magnitudes are in good agreement. It is also shown that the use of S20 photocathodes for direct photography with image tubes will introduce large color correction terms if V magnitudes are to be measured, unless a BG18 filter is used in addition to the GG 11 filter. (auth)

3386 SPECTROSCOPIC ANALYSIS OF THE WEAK-HELIUM-LINE STAR α SCULPTORIS. Vilhu, Osmi (Univ. of Helsinki). Ann. Acad. Sci. Fenn., Ser. A VI; No. 394, 5-37(1972).

Some high-dispersion spectrograms of the weak-helium-line star α Scl (B5, B8III) were analyzed. An LTE abundance analysis was carried out for the (line-blanketed) model with T_e = 15750°K and log g = 3.4 (from the continuum with Oke and Schild (1970) calibration of α Lyr, and Hγ profile with a compromise between ESW and Griem's theories). The microturbulence was 2 to 3 km/sec and v sin i = 15 km/sec. Helium was found to be underabundant apparently by a factor of 10. Chromium and iron were overabundant by a factor of nearly 10, scandium and titanium by nearly 100. The apparent overabundance factor of strontium was between 100 and 1000. Calcium K and H lines were unusually strong and probably of stellar origin. Sulphur and oxygen seemed to be slightly deficient (by factors of 2). Carbon, nitrogen, magnesium, and silicon were normal, although the SiIII/SiII ratio was high, as common in B stars. The spectrum of α Scl resembles those of Mn stars, but no MnII lines are visible in α Scl (<5mÅ). If Mn is overabundant, it can be so at the most by a factor of ten. On the basis of one spectrogram, the abundances of He, C, Mg, Si, Ca, Ti, and Fe in the B7V star π Cet were found to be quite normal. The pole-on hypothesis for α Scl was also studied, using conventional atmospheric models for uniformly rotating stars. It was found that, except for neutral helium lines, nearly break-up rotation can cause qualitatively similar line amplifications as observed in α Scl. However, the effect of rotation is much smaller than needed to explain the observations. (auth)

3387 STUDY OF STARS WITH METALLIC LINES USING A NARROW PASS BAND PHOTOMETRIC METHOD. Gerbaldi, Michele (Centre National de la Recherche Scientifique, Paris). Compt. Rend., Ser. B; 275: No. 8, 295-8(21 Aug 1972). (In French).

The behavior of the K lines of CaII and the variations in the abundances of metals in stars with metallic lines are examined in relation to normal A-type stars. (France)

3388 THERMODYNAMIC CRITICAL FIELD OF SUPERCONDUCTING NEUTRON STAR MATTER. Yang, C.-H. (Southern Univ., Baton Rouge, La.); Clark, J. W. Lett. Nuovo Cim.; 4: No. 17, 969-72(26 Aug 1972).

The work by Yang and Clark (1971) and Chao, Clark, and Yang (1973) was exploited to evaluate the zero-temperature thermodynamic critical magnetic field of superconducting neutron star matter, within the model of proton superfluidity of Chao, Clark, and Yang. (W.D.M.)

3389 UV CET-TYPE FLARE STARS. Gershberg, R. E.; Pikel'ner, S. B. Comments Astrophys. Space Phys.; 4: No. 4, 113-20(1972).

UV Cet-type stars are red dwarfs which from time to time display large and sharp brightness outbursts. Observational data, nature of the flares, flares in magnetic fields, and flare stars and stellar evolution are discussed. (W.D.M.)

3390 SIX ULTRASHORT-PERIOD BINARY STARS. Warner, Brian (Univ. of Cape Town). Sky Telesc.; 44: No. 6, 358-60(Dec 1972).

The spectra, periods, and models for the six ultrashort period binaries VV Pup, EX Hydrae, VW Hydri, WZ Sag, Z Chamaeleontis, and AM Canum Venaticorum are briefly reviewed. (W.D.M.)

3391 SOUTHERN OPEN STAR CLUSTERS. I. UBV–Hβ PHOTOMETRY OF 15 CLUSTERS BETWEEN GALACTIC LONGITUDES 231° AND 256°. Vogt, N.; Moffat, A. F. J. (Ruhr-Univ., Bochum, Ger.). Astron. Astrophys., Suppl. Ser.; 7: No. 2, 133-67(Oct 1972).

Fifteen clusters in this region were selected from the Catalogue of Star Clusters and Associations (Ruprecht, Alter, and Vanýsek 1970) with special emphasis placed on obtaining distant young clusters. Two-color and color–magnitude diagrams from the photoelectric UBV photometry for each cluster are discussed. The cluster parameters are summarized and reveal that seven young clusters are probable spiral arm tracers out to 4.2 kpc. Possible member supergiants (luminosity class I or II) were found in each of four of the clusters. Interstellar reddening is very small ($E_{B-V} \sim 0.3$) in most of the region and nearly independent of distance from one to four kpc. (auth)

3392 INVESTIGATION OF FOUR SOUTHERN OPEN CLUSTERS. Lindoff, U. (Lund Observatory, Sweden). Astron. Astrophys., Suppl. Ser.; 7: No. 2, 231-56(Oct 1972).

Magnitudes and colors were determined on the UBV system for stars in the southern open clusters NGC 5138, NGC 6134, NGC 6208, and IC 4651. The investigation was based on a combination of photoelectric and photographic photometry. Spectral classes for some of the brighter stars were determined from objective prism plates. Slit spectra for MK classification were available for a few stars. Dimensions, foreground absorptions, distances, and ages were determined. (auth)

3393 BINDING ENERGY OF NEUTRON STAR MATTER. Ellis, Dale; Sprung, D. W. L. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 50: No. 19, 2277-85(1 Oct 1972).

The energy per particle of neutron star matter is calculated using reaction matrix elements deduced from Reid's potential. These are parameterized so that the calculation is presented in a simple form. A maximum concentration of nearly 9% protons is found at about twice normal nuclear matter density. (auth)

3394 LIMITS ON GRAVITATIONAL RADIATION FROM TWO GRAVITATIONALLY BOUND BLACK HOLES. Gibbons, G. W.; Schutz, B. F. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 41P-5P(1972).

Upper bounds are computed for the energy emitted in gravitational radiation by two black holes falling into one another from rest at a range of separations. It is shown that before the ratio of total mass to proper separation exceeds 0.759 an event horizon must have formed around both. (auth)

3395 MAGNETIC STARS. Babu, G. S. D.; Sinvhal, S. D. (Uttar Pradesh State Observatory, Naini Tal, India). Bull. Astron. Inst. Czech.; 23: No. 5, 297-301(1972).

A statistical study of magnetic stars reveals that their mean rotational velocities do not depend on their magnetic field strengths. Also stars with low magnetic field strengths are mostly Mn stars and those with high field strengths are mostly Cr–Sr stars. (auth)

3396 MOLECULES IN ETA AQUILAE. Pande, M. C.; Joshi, G. C.; Tripathi, B. M.; Gaur, V. P. (Uttar Pradesh State Observatory, Naini Tal, India). Bull. Astron. Inst. Czech.; 23: No. 5, 301-5(1972).

The total numbers $I_\phi(AB)$ of a given molecule AB in a column extending between $\tau = 0$ to $\tau = 3.00$ have been calculated for various phases ϕ of light variations in η Aql for the molecules CO, CN, C_2, OH, NH, and CH. At all phases, the log $I_\phi(AB)$ values decrease in the order CO, OH, CH, NH, CN, and C_2. Consideration of log $I_\phi(AB) - \phi$ curves shows that the amplitude of the curves, the extent of the hump at $\phi = 0.15$, the slopes of the ascending and descending branches and the phase interval [between the instants on two sides of the minimum phase, at which log $I_\phi(AB)$ is less by 0.5 than the value of log $I_\phi(AB)$ at the minimum phase] decrease in the order of decreasing dissociation energy of the molecule, i.e., CO, CN, C_2, OH, NH, and CH. It is found that higher dissociation energy molecules form in higher layers at all phases and that for all the molecules considered, the average geometrical depth of formation progressively shifts toward deeper layers as one proceeds from maximum phase to minimum phase of light variation in the star. Finally the dissociation equilibrium abundances of molecular species closely follow the shape of the light curve including its asymmetry and hump and that the abundances of higher dissociation energy molecules reflect this correspondence better. (auth)

3397 TRAPPING OF CONDENSED PLASMA LOOPS AND ARCS IN COSMIC ATMOSPHERES. Woyk, E. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech.; 23: No. 5, 278-93 (1972).

In a collisionless atmosphere, charged particles would spiral along magnetic field lines from one end to the other and back, perpetually reflected from the two magnetic mirrors. If, however, the particle velocity is below the escape velocity, an upper level of reflection can occur: The highest level a particle of a given gyrofrequency and path radius can gain in the gravity field. Such particles would perpetually spiral up and down along the same branch of the magnetic loop. A critical velocity, which is about half of the escape velocity and which designates the point where the deviation of the path from the field line is minimum, also plays an important role. Between two collisions each particle spirals in agreement with the same formulae, valid for a collisionless plasma. Nevertheless, collisions affect the plasma jet in a quite specific way. In the most dense parts of atmosphere, just above the magnetic surface, the whole problem must be treated statistically. When proceeding to higher, more tenuous regions, some characteristic features slowly emerge from the chaotic motion. Owing to collision, the magnetic mirror often gradually rises and the plasma jet, bursting from below the surface, becomes impeded in attaining the surface again. Thus, suspended arcs, loops or clouds of condensed matter are often observed in the stellar atmosphere, remaining motionless for an unexpectedly long time, regardless of the extremely high velocity of the inner particles. The above mechanism gives a good explanation of shapes of planetary nebulae and solar prominences, of the evolution of solar flares and of some properties of the terrestrial magnetosphere. (auth)

3398 TRIVALENT TRANSITION-METAL IONS IN INTERSTELLAR DUST. Manning, P. G. (Inland Waters Directorate, Ottawa). Nature (London) Phys. Sci.; 239: No. 93, 87-8(9 Oct 1972).

Suggestions that most of the optical bands in spectra of Type I supernovae are caused by d–d transitions in Fe^{3+} ions in oxides or silicates have been criticised on the grounds that bands of common origin would show similar wavelength shifts with time (Branch and Patchett, Nature Phys. Sci. 233: 29 (1971)). These authors contend that the 6180 Å band, unlike the 4430 Å band, disappears 1 month after maximum. The 4100 and 4430 Å bands also show an initial rapid shift in wavelength with time. The present author feels that the 'disappearance' of the 6180 Å band is illusory. In the spectrum of SN-IC-4182 a new band appears at 6000 Å fourteen days after maximum, and after 24 days the 6180 Å band is "reduced" to a shoulder. Another band appears at 6300 Å after 67 days, making resolution of the 6000 and 6300 Å region difficult. Nevertheless, shoulders at ~6180 Å were evident by eye up to 184 days. The energies and assignments of Fe^{3+} bands in the spectra of supernovae and terrestrial silicates are shown tabulated; the biggest shifts occur for the 4100 and 4430 Å bands. It is suggested that early rapid shifts are caused by an oxygen environment around Fe^{3+} that is not in thermal equilibrium, and that short range order sets in after 20 days. The origin of the 5100 Å and 5700 Å supernova bands is stated to be particularly interesting, and is discussed. (UK)

3399 R-METHOD FOR DETERMINING THE HELIUM ABUNDANCE OF GLOBULAR CLUSTERS. Demarque, P.; Sweigart, A. V.; Gross, P. G. (Yale Univ., New Haven). Nature (London) Phys. Sci.; 239: No. 93, 85-7(9 Oct 1972).

It is stated that on the basis of calculations of the evolution of Population II stars it has been shown that the ratio R of theoretical horizontal branch (HB) to red giant (RG) star lifetimes is a function of their helium abundance. This ratio can also be written $R = N_{HB}/N_{RG}$ where N_{HB} and N_{RG} represent the numbers of the two kinds of stars in an individual globular cluster, and number counts can then be used to estimate the He abundance of the cluster. With the help of a theoretical calibration the He contents of a number of globular clusters for which observations were available were then determined. The calibration, however, neglected the effects of semi-convection in the interior of HB stars. A recalibration is presented taking into account the effects of semi-convection on HB evolution, and it is shown that the He abundance thus obtained for globular clusters is significantly lower than estimated by other methods. Some possible explanations for the apparent breakdown of the R-method are suggested and also possible causes of distortion

of the theoretical recalibration curve. Other methods available are discussed. (UK)

3400 ATMOSPHERE OF THE STAR HD 103877. Stickland, D. J. (Royal Greenwich Observatory, Herstmonceux, Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 29P-33P(1972).

A study of the spectrum of HD 103877 suggests that it is an evolved early F type star with apparent surface abundance anomalies typical of the classical Am stars. This agrees with the predictions of the element separation mechanism and recent model envelope calculations. (auth)

3401 MULTIPLE PERIODICITIES IN THE WHITE DWARF HL TAU-76. Page, C. G. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 25P-7P(1972).

Power spectrum analysis applied to the light curve of HL Tau-76 given by Warner and Nather (1970, 1971, 1972) has revealed at least three independent periodicities which entirely account for the phase deviations in pulse arrival times noted hitherto. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 3450.

3402 GAS-CHERENKOV DETECTOR FOR GAMMA-RAY ASTRONOMY. Helmken, H. F.; Hoffman, J. A. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). pp 1667-70 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

In an effort to study atmospheric and extraterrestrial gamma radiation in the region 10 to 100 MeV, a gas-Cherenkov detector has been designed, built, and successfully tested by balloon flight. The simplicity in design of a gas-Cherenkov counter permits detectors of large area and good angular resolution to be constructed. In the first flight of the detector on September 29, 1970, measurements were made of the atmospheric gamma-ray flux above 15 MeV, and upper limits given to the gamma-ray flux from the Crab Nebula and M87. A second successful flight on June 15, 1971, increased the exposure time on the Crab Nebula. (auth)

3403 DETECTION OF PULSED GAMMA RADIATION FROM THE CRAB NEBULA. Browning, R.; Ramsden, D.; Wright, P. J. (Univ. of Southampton, Eng.). pp 1671-82 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Data recorded from a high-altitude balloon flight from Palestine, Texas on January 9, 1971 to study gamma rays greater than 70 MeV from the Crab Nebula was analyzed for periodicity. The results indicated that the pulsed emission from NP 0532 extends into the high-energy gamma-ray region. The estimated source strength was consistent with an extrapolation from measurements at lower energies. (auth)

3404 SEARCH FOR ENERGETIC GAMMA-RAYS FROM LOCAL SOURCES OF RADIO-FREQUENCY RADIATION. Volobuev, S. A.; Galper, A. M.; Iyudin, A. F.; (and others) (Engineering Physical Inst., Moscow). pp 1683-96 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

An analysis of operation of the gamma-telescope, on board the Cosmos-251, 264, and 280 satellites to detect gamma-ray flux at $E\gamma \gtrsim 100$ MeV is presented. An additional gamma-radiation source was searched for in the regions of the sky with the known local radio radiation sources. A gamma-ray flux $\sim 5.10^{-4}$ $(cm^2\ sec)^{-1}$ was observed in the vicinity of 3C 120. The time of measurements coincided with outbursts of radiation coming from 3C 120. If the registered gamma-ray flux comes from 3C 120, the magnitude of the outbursts of the latter in the gamma rays is $\sim 2.10^{47}$ erg/sec. (auth)

3405 SEARCH FOR 10^{11} TO 10^{12} eV GAMMA RAYS FROM DISCRETE SOURCES. Fazio, G. G.; Helmken, H. F.; O'Mongain, E.; Rieke, G. H.; Weekes, T. C. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). pp 1697-1702 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

For the last 3 years, the 10-m optical reflector at Mt. Hopkins, Arizona, has been used to search for cosmic gamma rays by the detection of atmospheric Cherenkov radiation from energetic-particle showers. The principal source investigated was the Crab Nebula, which was observed for over 200 hr. Other sources studied included M87, M82, Cyg A, 3C 273, Sgr A, and Cyg X-1. None showed an effect greater than 3 standard deviations. The upper limit deduced from the Crab observations $(8.6 \times 10^{-11}$ photon/cm^2 sec at 2×10^{11} eV) permits a lower limit of 3×10^{-4} gauss to be placed on the average magnetic field in the Nebula. (auth)

3406 UPPER LIMITS OF LUMINESCENCE OF SOME EXTRAGALACTICAL OBJECTS IN THE RANGE OF RIGID GAMMA-RAYS. Bratolyubova-Tsulukidse, L. S. (Moscow State Univ.); Pryakhin, E. A.; Savenko, I. A.; (and others). pp 1703-7 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

The results of measurements of rigid gamma-quantum intensity carried out on Cosmos-208 with a gamma-telescope were used to determine the upper limits of luminescence I_γ of some extragalactical objects seen by the instrument during the flight. The values of I_γ for 30 to 150 MeV which correspond to 95% reliable probability are given for various sources. (auth)

3407 POSSIBLE HIGH ENERGY GAMMA-RAY FLUX FROM CYGNUS REGION. Vladimirskii, B. M.; Pavlov, I. V.; Stepanian, A. A.; Fomin, V. P. (Crimean Astrophysical Observatory, Moscow). pp 1708-13 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

The Crimean Astrophysical Observatory installation for Cherenkov light flashes of cosmic-ray air shower detection is described briefly. It consists of two independent detectors with four 1.5-meter parabolic mirrors with photomultipliers in their foci. The resolving time of coincidence is 5 nsec. A flux of high-energy gamma rays ($E > 2{,}5.10^{12}$ eV) in the direction of Cygnus region is revealed. The excess of the flux is approximately 2.10^{-11} cm^{-2} sec^{-1} (3.7σ). A possible explanation of the gamma-ray flux is considered. (auth)

3408 B2 CATALOGUE OF RADIO SOURCES. SECOND PART. Colla, G.; Fanti, C.; Fanti, R.; (and others) (Univ., Bologna). Astron. Astrophys., Suppl. Ser.; 7: No. 1, 1-34 (Sep 1972).

The catalog lists 3013 radio sources observed at 408 MHz with the Bologna Northern Cross Telescope. It covers an area of 0.53 ster. between 24°02′ and 29°30′ down to 0.25 f.u. Results are given for the radio spectra of the 4C sources and for the log N–log S relationship. (auth)

3409 POSSIBLE EXPLANATION OF NON-POWER-LAW RADIO SPECTRA OF COSMIC RADIO SOURCES. Gnedin, Yu. N.; Dolginov, A. Za.; Fedorenko, V. N. (Ioffe Inst. of Physics and Tech., Moscow). JETP Lett. (USSR) (Engl. Transl.); 16: No. 1, 31-2(5 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 1, 45-7(5 Jul 1972).

It is shown that a spectrum of the type proposed by Brande et al. (1971) follows naturally from the assumption that the electrons are scattered and accelerated by moving magnetic inhomogeneities if their range $\Lambda(E)$ in a wide energy interval $E > E_0$ decreases with energy like $\Lambda(E) = \Lambda_0(E_0/E)$. Such a $\Lambda(E)$ dependence can be realized in acceleration of Alfven waves, if the exponent of the turbulence spectrum is close to $\nu = 3$. (W.D.M.)

3410 BINARY STARS AS X-RAY SOURCES. Burbidge, G. Comments Astrophys. Space Phys.; 4: No. 4, 105-11(1972).

The idea that many if not most of the powerful galactic x-ray sources are generated in binary star systems containing at least one exotic object together with gas is gaining momentum. It therefore seemed worthwhile both to summarize the history of this idea and to discuss some of the fruitful lines of investigation stemming from it and also some of the unsolved problems. (W.D.M.)

3411 NEUTRON STAR IN CRAB NEBULA: REALLY? Michel, F. C. (Rice Univ., Houston, Tex.). Comments Astrophys. Space Phys.; 4: No. 4, 101-4(1972).

The theoretical and experimental developments leading to the conclusion that the Crab Nebula contains a neutron star are briefly reviewed. The observational evidence from spatial, temporal, and energy resolutions would give a thermal x-ray

spectrum yielding values for radius and surface temperature. (W.D.M.)

3412 SEARCH FOR LONG-PERIOD X-RAY PULSATIONS IN THE NP 0527 REGION. Frontera, F.; Fuligni, F.; Brini, D.; Cavani, C. (TESRE/CNR, Bologna). Lett. Nuovo Cim.; 5: No. 2, 131-4(9 Sep 1972).

Evidence for a new source of pulsating x rays at 30 to 100 keV has been recently reported by Sadeh et al. (1972). Association of this source (period 3.8266 s) with NP 0527 has also been suggested. A search was performed for pulsations around this period by re-analyzing the data obtained in a balloon flight where the Crab Nebula was observed for over 4 hours. (W.D.M.)

3413 MICROWAVE OBSERVATIONS OF A PARTIALLY IONIZED INTERSTELLAR CLOUD. Chaisson, E. J. (Harvard Coll. Observatory, Cambridge, Mass.). Nature (London) Phys. Sci.; 239: No. 93, 83-5(9 Oct 1972).

High resolution-spectroscopy has enabled detection of recombination lines of excited hydrogen, carbon, and elements of intermediate mass from a cool cloud in the direction of W3A. (auth)

3414 BLUE STELLAR RADIO SOURCES WITHOUT ULTRAVIOLET EXCESS. Browne, I. W. A.; McEwan, N. J. (Univ. of Manchester, Eng.). Nature (London) Phys. Sci.; 239: No. 94, 101-2(16 Oct 1972).

It is stated that 11 radio sources have been identified with stellar objects that, although they appear definitely blue on the Palomar Sky Survey prints, do not show the characteristic uv excess normally associated with quasistellar radio sources. The arguments for using a detectable uv excess as a necessary requirement for a true quasar are examined. At redshifts >2.0 there is a tendency for the uv excess to decrease with redshift, bearing out the suggestion that quasars with redshifts >2.3 may not exhibit any uv excess; this suggestion is supported by recent photometric results on 4G 05.34, the quasar with the highest known redshift (z = 2.877), and whose colours are reported to be almost indistinguishable from a normal main sequence F-star. It seems that the 11 objects might fall into one or more of the following classes: very compact blue N-galaxies; quasars with redshifts in the range 0.5 to 0.8; or quasars with redshifts >2.3. (UK)

3415 HER X-1. A PRECESSING BINARY PULSAR. Brecher, K. (Univ. of California, La Jolla, San Diego). Nature (London); 239: No. 5371, 325-6(6 Oct 1972).

It is stated that recent observations of the two pulsating binary x-ray sources Her X-1 and Cen X-3 have led to a great deal of speculation concerning the x-ray emission mechanism involved. From orbital parameter considerations it is natural to suppose that matter is accreted on one star from its companion. In the case of Cen X-3 the low-mass companion is presumably a collapsed object with high surface gravity (white dwarf, neutron star, or "black-hole"), and thus a large source of gravitational energy is available for radiation. No other property of the observed x-ray emission is, however, easily explainable; and furthermore even in a plausible binary accretion model there seems to be no natural explanation for the observed few-second x-ray pulsational period. Also the high "Q" of the pulses, their short rise time, and the existence of an "interpulse" in Her X-1 are difficult to understand on the accretion hypothesis. A tentative phenomenological suggestion is put forward; that Her X-1, and also perhaps Cen X-3, is a precessing binary pulsar. The pulse period (≈1,245) is approximately equal to the average period of known radioemitting pulsars, and the existence of an interpulse is a common pulsar feature; the x-ray Doppler curve clearly indicates the binary nature. In addition to the 1.7 day orbital period a 36 day period persisted throughout the year of observation, during which the x-ray source was undetectable for about 27 days, and if Her X-1 is a pulsar, emitting radiation in a pencil beam normal to its spin and equatorial axis, the 36 day period can be understood as a consequence of the free precession of the beam in and out of the line of sight. The precession must result from the binary nature of the system, and probably from nongravitational forces in the system; perhaps plasma, current or other spatially asymmetric electromagnetic forces resulting from the binary nature of the system can supply the torque necessary to initiate free precession. (UK)

3416 CYGNUS X-3: DYING SWAN OR VIGOROUS PHOENIX. Mitton, S. New Sci.; 56: No. 817, 200-2(26 Oct 1972).

On the evening of September 2, 1972 a new star burst in the radio sky to become the most spectacular outburst ever observed by radio astronomers. A massive programme of international collaboration has documented this unique event in great detail. The radio flare probably originated in a rapidly expanding cloud of high-energy electrons. (auth)

3417 DISCOVERY OF GIANT RADIO OUTBURST FROM CYGNUS X-3. Gregory, P. C. (Univ. of Toronto); Kronberg, P. P.; Seaquist, E. R.; (and others). Nature (London); 239: No. 5373, 440-3(20 Oct 1972).

A giant radio outburst was observed from the x-ray source Cygnus X-3 on September 2, 1972. Flux density measurements were obtained at 10,522, 6,630, and 3,240 MHz as well as linear polarization measurements at 10,522 MHz. The evidence suggests a model of synchrotron radiation from an expanding cloud of relativistic particles. A computed upper limit for the source distance of ≤400 kpc implies that the source of the radio emission is galactic. (auth)

3418 LARGE OUTBURST OF CYGNUS X-3. Gregory, P. C. (Univ. of Toronto). Nature (London); 239: No. 5373, 439-40(20 Oct 1972).

The recent radio outburst of Cygnus X-3 is described, an overall picture of the source which has been gleaned from observations at many wavelengths is presented. (auth)

3419 UNUSUAL RADIO EVENTS IN CYGNUS X-3. Hjellming, R. M.; Balick, B. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature (London); 239: No. 5373, 443-6(20 Oct 1972).

Observations made at Green Bank confirm the findings of Gregory and others (Nature 239:439 and 440 (1972)). (auth)

Solar Phenomena

Refer also to abstracts 2552, 2590, 3349, 3397, and 3462.

3420 (AD-740233) FINAL REPORT, OCTOBER 1, 1970-AUGUST 31, 1971. (California Univ., Berkeley. Space Sciences Lab.). 1971. Contract N00014-69-A-0200-1040. 8p. NTIS.

In the early 1960's two new types of motion in the solar atmosphere were discovered: the 5-minute oscillations and the supergranulation. The 5-minute oscillations consist of a predominantly vertical hydrodynamic wave motion in the photosphere and chromosphere with amplitudes around 500 m/sec. The supergranulation consists of a series of convective cells, 30,000 km in diameter, in which material rises at the center, flows horizontally outward, and falls at the boundaries. The horizontal motion in the supergranulation was clearly observed, but its vertical motion was observed only marginally at best. The observations described were made at the Mt. Wilson Observatory 150-foot solar telescope. (auth) (GRA)

3421 (AD-740580) MAGNETIC FIELDS IN SOLAR PROMINENCES: A REVIEW. Air Force Surveys in Geophysics. Rust, David M. (Air Force Cambridge Research Labs., L. G. Hanscom Field, Mass.). 12 Jan 1972. 33p. (AFCRL-72-48; AFCRL-AFSIG-237). NTIS.

The development and regular use of magnetographs designed especially for observations of magnetic fields in prominences has sparked new theoretical interest in the structure of these solar objects. Several interesting new models for active prominence field structure have been proposed recently. Most of these models envision force-free magnetic fields in the prominences, and there is some evidence for helical magnetic fields in eruptive prominences. Helical structure is a characteristic of many force-free field models. However, Rust and Roy (1971) have had some success in fitting current-free fields to loop prominences, which are frequently observed in the hours immediately following a major flare. The implications of these observations are discussed. (auth)

3422 (AD-740711) TO ISOLATE AND EXAMINE ALL SIGNIFICANT PHENOMENA ASSOCIATED WITH THE YELLOW CORONAL LINE AT 5694 A. Final Report. Low, R. J. (High Altitude Observatory, Boulder, Colo. Harvard Univ., Cambridge, Mass.). 4 Oct 1954. Contract Nonr-393(02). 7p. NTIS.

Research under the yellow line contract may be divided conveniently into three phases; namely, yellow coronal line, flares, and active prominences; structure of the solar corona; and line profile analysis of active center phenomena and identification of yellow coronal line. (GRA)

3423 (AD-740712) RECENT STUDIES OF CHROMOSPHERIC SPICULES. Research Report No. 1. Rush, J. H.; Roberts, W. O. (High Altitude Observatory, Boulder, Colo.). 16 Nov 1953. Contract N8onr-648(01). 24p. NTIS.

The authors undertook the present research to develop as detailed as possible an understanding of the behavior of spicules, and particularly to evaluate more accurately their numbers, dimensions, and velocities—the parameters that bear most significantly on questions of material and energy transport. (auth) (GRA)

3424 (AD-740713) HIGH ALTITUDE OBSERVATORY ISOPHOTAL CONTOUR DENSITOMETER. Fowler, F. E.; John-

son, D. S.; Billings, D. E. (High Altitude Observatory, Boulder, Colo.). 29 Jan 1952. Contract N8onr-64801. 33p. NTIS.

For many years the High Altitude Observatory has engaged in a program of observations of the spectacular motions of giant solar prominences rendered visible in monochromatic light by the Climax coronagraph. Motion picture studies of these films and similar ones taken at other observatories have revealed the extraordinary nature of the force fields involved, and have pointed to the need for further quantitative work, particularly that involving the measurement of the growth of luminous areas in prominences as a function of time. Because of the limitations for this work of other contouring methods the staff of the High Altitude Observatory has sought to develop a new type photometer capable of analyzing films from motion picture sequences fast enough for the problem at hand. The isophotal contour densitometer described in the report is a first breadboard model of an instrument of this type. (GRA)

3425 (AD-740725) IONIZATION AND KINEMATICS OF YELLOW-LINE CORONAL REGIONS. Boardman, W. J.; Billings, D. E. (Colorado Univ., Boulder. Dept. of Astro-Geophysics). 1972. Contract Nonr-393(04). 36p. NTIS.

The ionization of Ca XV was computed from observations of the strengths of the coronal lines lambda 5694 and lambda 5446 and the neighboring regions of the continuum. This was compared with a theoretical ionization curve including dielectronic recombination. Discrepancies are discussed and explanations suggested in the form of turbulence and/or ordered mass motion. Estimates were calculated of the dimensions of the observed condensations along the line of sight. (auth) (GRA)

3426 ENERGY SPECTRA OF SOLAR FLARE ELECTRONS. Lin, R. P. (Univ. of California, Berkeley). pp 1805-10 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

The processes of acceleration, escape from the Sun, and subsequent propagation in the interplanetary medium of 10 to 100-keV solar-flare electrons were studied by comparing the energy spectra for ~100 keV solar flare electron events observed by Explorer-35 and IMP-5 in the period mid-1967 to mid-1970. For each event a spectral index δ where $dn_e/dE \propto E^{-\delta}$ was calculated from the observed fluxes. It was found that 80% of the events had a value of δ from 2.5 to 4.0 in the energy range 10 to 100 keV. A sharp cutoff in the number of events exists for values of δ both <2.5 and >4.0. No variation of δ was evident as a function of solar longitude of the parent flare. Four point spectra (>18 keV, >45 keV, >80 keV, >120 keV) from IMP-5 showed several events for which the spectrum was less steep between 18 and 45 keV than above 45 keV. The limited range of δ appeared to be a characteristic of the acceleration mechanism, although it was possible that the less steep spectra below 45 keV may have been due to energy loss during escape. (auth)

3427 TEMPORAL CHARACTERISTICS OF GENERATION OF CORPUSCULAR AND ELECTROMAGNETIC RADIATION BY SOLAR FLARES. Gainova, L. E.; Kolomeets, E. V.; Ivanov, V. I. (Kazakh State Univ., Alma-Ata, USSR). pp 1811-18 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

More than a hundred solar flares accompanied by fluxes of hard x-ray radiation (≥ 20 keV) and microwave radio emission (>3.10 Mc/s) were observed. It is shown that 58% of the total momentum splashes begin 1-6 min before the moment of appearance of optical burst in H_α or simultaneously with it. The intensity maxima of 74% of the total splashes of the x-ray radiation occur 1 to 8 minutes before the optical burst maximum. Results indicate the nonthermal burst phase of a flare when the generation of charged particles occurs. Thus, it is concluded that the development of optical flare in H_α, accompanied by slowly changing x-ray radiation, is the secondary effect particle acceleration by the flare. The authors have calculated the number of accelerated electrons in the flare region and have determined their energetic spectra using the available experimental data on hard x-ray radiation and microwave radio emission. It is assumed that the radiation mechanism character of the x-ray flux appears to be the bremsstrahlung by nonrelativistic electrons, and microwave radio emission is due to synchrotron radiation by relativistic electrons. The spectrum of electrons can be represented by a power law of the form $dNe/dE = KE^{-\gamma}$, where the exponent of the electron energy spectrum should be 1.5 to 3.3, while the exponent of the x-ray splash spectrum is within $2.7 < \gamma < 4.5$. The number of accelerated electrons in studied splashes is equal to 10^{30} to 10^{39}, and the splash energy should be 10^{27} to 10^{31} erg. The solar electron flux, responsible for radio and x-ray splashes in the lower corona, is closely correlated with the solar proton flux. It is shown that electrons of different energy account for the x-ray burst effect in the energy region <70 keV and for microwave radiation splashes. The number of protons produced by a series of solar flares is calculated using data obtained on the surface of the Earth. Assuming that the spreading of solar protons is diffusive the number of protons is found to be 10^{32} to 10^{33}. Proton spectra obtained for considered events can be represented by a power law, where the exponent of spectra is found to be $\gamma = 2-4$. (auth)

3428 MARCH 30, 1969 SOLAR PROTON EVENT: DIRECTIONAL MEASUREMENTS OF SOLAR PROTON FLUXES IN INTERPLANETARY SPACE. Balogh, A.; Dyer, C. S.; Engel, A. R.; Hynds, R. J.; Quenby, J. J. (Imperial Coll. of Science and Tech., London). pp 1819-24 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Three characteristics of the March 30, 1969 solar particle event, long delay before onset, slow rise time, and high degree of isotropy at high energies, are described. It is suggested that the main component of the event near the Earth was the result of crossfield diffusion at all distances from the Sun to the Earth and beyond. (auth)

3429 DATA ON SOLAR PROTON EVENTS RECORDED IN THE STRATOSPHERE DURING THE 20TH SOLAR CYCLE. Bazilevskaya, G. A.; Charakhchyan, A. N.; Charakhchyan, T. N.; Lazutin, L. L.; Stozhkov, Yu. I. (Lebedev Inst. of Physics, Moscow). pp 1825-36 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Information on solar proton events observed in the stratosphere in 1966-1971 over the Murmansk and Antarctic regions is presented. The energy interval of recorded protons was from 100 to 500 MeV. The propagation conditions in interplanetary space are discussed. Using a simple diffusion theory the proton spectra near the sun, total proton number and total energy in the interval of 100 to 500 MeV for some solar proton events of the 19th and 20th solar cycles are calculated. (auth)

3430 PROPAGATION OF LOW ENERGY SOLAR PROTONS ASSOCIATED WITH THE NOVEMBER 2, 1969 SOLAR FLARE. Balogh, A.; Hedgecock, P. C.; Hynds, R. J.; Sear, J. (Imperial Coll. of Science and Tech., London). pp 1837-42 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

The rising intensity phase of the November 2, 1969 solar proton event is discussed on the basis of pitch angle distributions obtained by combining directional proton intensity measurements with the interplanetary magnetic field measured on the same spacecraft. A short description is given for the proton intensity trough which occurred on November 7; it is suggested that it occurred as a result of a particular magnetic regime associated with a high-velocity plasma stream. (auth)

3431 COSMIC RAY ENERGY LOSSES AT 1 A.U. DURING SOLAR PROTON EVENTS. Palmer, I. D. (CSIRO, Sydney). pp 1843-8 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

A Monte Carlo technique was developed in order to study the propagation through the interplanetary medium of cosmic-ray particles released at the sun. When the processes of diffusion, convection, and energy loss (by adiabatic deceleration) were included, the technique could be used to investigate the variation with time of mean particle energy at 1 AU after the injection of monoenergetic particles at the sun. The dependence of the resulting mean energy decrease with time upon diffusion conditions in interplanetary space was studied. These energy decays were compared with a recent satellite observation of energy loss during a solar proton event. (auth)

3432 SOLAR COSMIC RAY OBSERVATIONS DURING THE SEPTEMBER AND NOVEMBER 1969 EVENTS. Masley, A. J.; Satterblom, P. R. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). pp 1849-52 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Observations during the September and November 1969 events were made by the McDonnell Douglas OGO-6 and polar ground-based riometer experiments. The November 2 event was one of the largest observed since November 1960. The event was due to flare activity one day behind the west limb. A peak intensity for protons from 5 to 80 MeV of 1600/cm^2-sec-ster was reached at 1230 UT November 2 and 0200 UT on November 3. The peak riometer absorption was 14.5 dB at 30 MHz. Large variations in intensity were observed across the polar caps. Stable features in the polar intensity profile which could be recognized during each pass were observed for about 24 hours. (auth)

3433 STABLE PARTICLE COMPONENT 30 TO 400 KeV IN INTERPLANETARY SPACE. Anderson, K. A.; Lin, R. P. (Univ. of California, Berkeley). pp 1853-7 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Observations on the IMP-6 (Explorer 43) spacecraft during quiet times show a stable low-energy (30 to 400 keV) particle component. These particles are identified as protons or higher Z nuclei. Their energy spectra fit reasonably well to an extension of the spectrum of quiet time cosmic-ray protons measured above 2 MeV. (auth)

3434 INVESTIGATION OF A SOLAR WIND BY MEANS OF JUPITER RADIOBURSTS. Kovalenko, V. A.; Malyshkin, V. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Irkutsk, USSR). pp 1992-2002 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

The data of geomagnetic activity and Jupiter radioemission were analyzed at frequencies 7.6 to 41 MHz. ΣKp was used as an indicator of solar wind "power." It is stated that the shock waves producing Forbush-decreases in cosmic-ray intensity and the geoeffective solar-wind flows while crossing Jupiter cause radiobursts within the decameter range. A cross-correlation analysis was performed between the appearance of Jupiter radiobursts and the geomagnetic disturbances. The correlation coefficient on data of 1964 is equal to 0.66 ± 0.04 with all radiobursts taken into account and to 0.88 ± 0.06 for bursts only of classes 2 and 3. Based on the above given analysis a conclusion is drawn that the geoeffective solar plasma flows propagate up to Jupiter's orbit with a constant velocity without any essential turbulization. Solar-plasma velocities between the orbits of Jupiter and the Earth were determined by the Jupiter radioburst delays with regard to corresponding geomagnetic disturbances. It was found that the average velocity of geoeffective flows for 1960 corresponds to 700 km/s and decreases to 1964 up to 600 km/s. The mean velocities of shock waves from the Sun to the Earth are also defined as well as those between the orbits of the Earth and Jupiter. Strong shock waves are shown to delay between the Sun and the Earth and then propagate up to Jupiter's orbit with the mean velocities ~700 km/s. (auth)

3435 ANISOTROPIES AND THE UNEVEN ILLUMINATION BY SOLAR COSMIC RAYS. Gall, Ruth; Bravo, Silvia; Orozco, Adolfo (Univ. Nacional Autonoma de Mexico, Mexico City). pp 2003-8 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Analysis was made of the assumption that the latitudinal structure of solar fluxes of 20 to 300 MeV protons is due to the existence of preferential regions of access at the magnetopause and in the tail and to the anisotropic propagation in the interplanetary medium. It was assumed that these particles propagate in the geomagnetic field along orbits, without scattering. It was found that a) the neutral sheet is a preferential region of access for illumination of auroral peaks, b) the polar peaks are illuminated either by preferential propagation along the tail or by anisotropic fluxes. Parker and radial anisotropies contribute poorly to the illumination of high latitudes. The valleys are associated with regions of inhibited access. (auth)

3436 NORTH-SOUTH ASYMMETRY IN POLAR CAP REGIONS. Domingo, V.; Page, D. E. (European Space Research and Technology Centre, Noordwijk, Netherlands). pp 2009-20 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

An experiment on the polar ESRO I/Aurorae satellite recorded on January 24, 1969 a particle flux over the central north pole which at times was a factor of 7 greater than that seen over the south pole. This asymmetry is discussed in relation to the interplanetary magnetic field direction measured at the same time by the HEOS spacecraft and comparison is made with the November 2, 1967 opposite asymmetrical configuration as observed by Evans and Stone (1969). From the evidence of two events it would appear that field connection associated with a southward interplanetary field plays a significant role and that the polar asymmetry is probably further enhanced by anisotropic particle arrival (Venera 6 data, Vernov 1969). The data illustrates the futility of carrying out geomagnetic cut-off calculations at latitudes above 65° without having a knowledge of interplanetary field conditions. It is noted, without any conclusions being drawn, that the solar flare giving rise to the north pole excess was at 20°N, 09°W while that for the south pole excess was at 18°S, 02°W. (auth)

3437 INVESTIGATION OF RECURRENCE PHENOMENA IN GEOMAGNETIC Kp-DATA AND SOLAR MAGNETIC FIELDS AND THEIR INTERRELATIONSHIP. Hauska, H. (Uppsala Univ.). pp 2030-5 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Kp-data and data for the photospheric magnetic field were investigated by means of power spectrum technique for the year 1964. A model of solar active longitudes was constructed and investigated. Cross-correlation functions were computed for solar magnetic fields with both Kp and the interplanetary magnetic-field directions. The results showed that there might exist active longitudes during 1964 and that these could be identified with Bartels M-regions. The correlations showed a clear connection between solar and interplanetary fields while no definite statement could be made on the connection between Kp and the photospheric fields. Power spectrum analysis on Kp-data could be used as a measure of the stability of the interplanetary sector structure and eventually as an indicator of large-scale solar features. (auth)

3438 ADVANCES IN THE ASTRONAUTICAL SCIENCES. VOLUME 29. THE OUTER SOLAR SYSTEM. PART I. Proceedings of the AAS 17th Annual Meeting, Seattle, Washington, June 28-30, 1971. Vagners, Juris (ed.). American Astronautical Society Publication. Tarzana, Calif.; American Astronautical Society (1971). 616p. (CONF-710657-(Pt.1)). Univelt, Inc., Tarzana, Calif.

Sessions reported in Part I include: national and program plans; natural environment, planetary structure, and composition; technology utilization; navigation and guidance; and scientific experiments and instruments. (W.D.M.)

3439 ADVANCES IN THE ASTRONAUTICAL SCIENCES. VOLUME 29. THE OUTER SOLAR SYSTEM. PART II. Proceedings of the AAS 17th Annual Meeting, Seattle, Washington, June 28-30, 1971. Vagners, Juris (ed.). American Astronautical Society Publication. Tarzana, Calif.; American Astronautical Society (1971). 739p. (CONF-710657-(Pt.2)). Univelt, Inc., Tarzana, Calif.

Sessions reported in Part II include: mission analysis/design; planetary entry; system design and integration; development strategy and design techniques for long life, endurance, and operability; and beyond the solar system. (W.D.M.)

3440 ANISOTROPIES IN 0.3 MeV SOLAR PROTONS. Innanen, William Glen. Iowa City, Iowa; Univ. of Iowa (1972). 176p. University Microfilms Order No. 72-26,696.

Thesis.

A study of 0.3 to 6.3 MeV solar proton anisotropies in interplanetary space was made from Explorer 35 solid state detector data. During the period from August 9, 1967 to July 12, 1970, 15 events were observed essentially clear of magnetospheric influences, and 9 of these were "simple" events (i.e., primarily due to a single solar flare). For these 9 events the heliocentric radial component of the anisotropy, integrated over each event, yields the total number of 0.3 to 6.3 MeV protons flowing past the spacecraft. These values range from 10^{33} to 10^{35} protons/sr. A study of the relationship of the anisotropy vector to the interplanetary magnetic field shows (a) that in the decay phase of simple events there is little or no correlation between their respective directions, but (b) that in the rise phase a correlation does exist which is consistent with a model of the anisotropy vector being composed of two components: field aligned and radial. In the

decay phase of most simple events and in the rise phase of a few, the radial component of the anisotropy was found to be in reasonable agreement with the convective anisotropy predicted by the Compton–Getting effect as applied to an isotropic distribution in the rest frame of the solar wind. Thus, it is concluded that the 0.3 MeV solar proton anisotropy is primarily composed of two components: a radial anisotropy caused by convection of the protons by the solar wind which predominates during the decay phase of an event, and a field aligned component due to diffusion which predominates in the rise phase of an event. In the rise phase of a few events this was found not to be the case, due presumably to the diffusive component not being field aligned. During the decay phase of several events the diffusive component of the anisotropy was directed along the magnetic field toward the Sun, indicating that a positive radial proton density gradient had been established by convection. Solar proton anisotropies observed in the magnetotail during the rise phase of the events under study were observed to be across the tail, generally in the $+Y_{SE}$ direction. During the decay phases, however, these anisotropies were found to be much more irregular in both direction and magnitude. (Diss. Abstr. Int., B)

3441 ENERGY CHANGES OF SOLAR COSMIC RAYS. Englade, R. C. (Air Force Cambridge Research Lab., Bedford, Mass.). J. Geophys. Res.; 77: No. 31, 6266-70(1 Nov 1972).

The theoretical time dependence of a distinct feature in the differential energy spectrum of solar-flare cosmic rays was investigated previously, based on a special case of the radial Fokker–Planck transport equation and its accompanying initial and boundary conditions, Gleeson and Ng, J. Geophys. Res., 76, 1971. Their results led them to take issue with assertions of Jokipii, Phys. Rev. Lett., 26, 1971, and Murray, et al., Phys. Rev. Lett., 26, 1971, that diffusive effects can be ignored at low energies and that the effective decay phase time constant (τ) should therefore be nearly identical to the quantity $T/(dt/dt)$ at a point of observation. The analysis of Gleeson and Ng is now applied to a radial propagation model that allows for an absorbing boundary at a finite heliocentric radius L, and the late time behavior of τ for the effective radial diffusion coefficient $(k) = k_0 r$ and the effective radial diffusion coefficient = constant. These results are discussed in the light of the findings of Jokipii and Murray et al. (J.C.W.)

3442 CHARACTERISTICS OF QUIET AS WELL AS ENHANCED DIURNAL ANISOTROPY OF COSMIC RADIATION. Rao, U. R.; Ananth, A. G.; Agrawal, S. P. (Physical Research Lab., Ahmedabad, India). Planet. Space Sci.; 20: No. 11, 1799-1816(Nov 1972).

It is shown that the model which has been successful in explaining the anisotropy of low-energy cosmic radiation of solar origin in terms of simple convection and field aligned diffusion can also be extended to explain both the quiet and enhanced diurnal variation of cosmic radiation at higher energies. The enhanced diurnal variation which shows a maximum around ~2000 hr is shown to be caused by the superposition of normal convection and enhanced field aligned diffusion due to an enhanced positive density gradient of approximately 10 per cent/AU. The enhanced gradient in the early part of the event is caused by a depletion of cosmic-ray intensity along the garden-hose direction and later in the event ($T \geq 4$ days) is caused by an excess flux from the anti-garden-hose direction. The quiet-day average diurnal anisotropy of cosmic radiation can be understood as due to an equilibrium between the convective and diffusive flow, resulting in a corotation vector along the 1800 hr direction. The observed amplitude of the annual mean diffusive vector is consistent with a positive radial density gradient of ~4.5 per cent/AU, which agrees with other radial gradient measurements. The diffusive vector during both quiet and enhanced anisotropy periods is shown to be along the interplanetary field direction. The ratio of perpendicular to parallel diffusion coefficient under normal conditions is derived to be ≤0.05 indicating that the transverse gradients, in general, are negligible. (auth)

3443 USE OF MORE UNIVERSAL, DIMENSIONLESS FORMULAE FOR SPHERICAL MEDIA. Woyk, E. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech.; 23: No. 5, 268-78 (1972).

Physical problems are usually treated by proceeding from point to point. In spherical media where levels of equal physical characteristics are concentric spheres, the points should rather be replaced by spheres. This renders the method of computation much easier, the results much simpler. In addition a quite universal, dimensionless system of units has to be introduced, applicable to any cosmic medium regardless of its dimensions and other physical parameters. Many trajectories are now defined by one single basic parameter E_0, corresponding to an extreme sphere of radius $r_0 = 1$, and paths with equal E_0 become identical. If at a point of interruption (e.g., collision) only direction and e.g., velocity, are known E_0 and $r_0 = 1$ are very easily determined. In an imperfectly spherical medium corrections are made by considering the displacement of the common center of curvature of the concentric spheres. For comparison the quite general introductory formulae are applied to Kepler orbits, to the spiral motion of charged particles in extended magnetic and gravity fields and to radio paths in ionized media with varying electron distribution. (auth)

Galaxies

Refer also to abstract 4254.

3444 (AD–740395) HIGH-FREQUENCY STUDY OF CYGNUS A. Bing, K.; Yip, W.; Seielstad, G. A. (Owens Valley Radio Observatory, Pasadena, Calif.). 1972. Contract N00014-67-A-0094-0019. 30p. NTIS.

Measurements at 8300 and 9600 MHz were combined to map the distribution of total radiation across Cygnus A with a beam of half-power width about 20 seconds EW × 30 seconds NS. Steep brightness contours were noted on the outer edges and more gradual inner extensions towards the optical galaxy. The brightest peaks within each radio component had flatter spectra than the rest of the source. The distributions of linearly polarized radiation at both 8300 and 9600 MHz were also mapped. Nearly everywhere in the source the degree of polarization at 9600 MHz exceeded that at 8300 MHz. The rotation measures varied more or less systematically across Cygnus A from a very large negative value at the following edge to a positive value on the preceding edge. (auth) (GRA)

3445 (AD–740396) GROSS PROPERTIES OF FIVE SCD GALAXIES AS DETERMINED FROM 21 CM OBSERVATIONS. Rogstad, D. H.; Shostak, G. S. (Owens Valley Radio Observatory, Pasadena, Calif.). 1972. Contract N00014-67-A-0094-0019. 21p. NTIS.

Neutral hydrogen studies of the five Scd galaxies M33, NGC 2403, IC342, M101, and NGC 6946 revealed substantial similarities in their hydrogen distributions and rotation curves. It was found that about 80% of the observable HI lies within the boundary defined by the Holmberg diameter for each galaxy. The ratio of the HI mass to the total mass contained within this same boundary has a mean value of about 0.11. The central HI surface density is also nearly a constant within the Scd classification. It was found that all the HI global properties and ratios are nearly constant or scale approximately with Holmberg radius or total mass. An observed correlation of maximal rotation velocity with Holmberg radius allowed characterization of the total mass with only one parameter. Because of the very flat rotation curves observed for these Scd galaxies, total masses extrapolated to infinite radius are not known. Surface mass–luminosity ratios must reach values of about 20 at the Holmberg radius. (auth) (GRA)

3446 DISTRIBUTION OF STARS AND OBSCURING MATTER IN A MONOCEROS FIELD. Karlsson, B. Astron. Astrophys., Suppl. Ser.; 7: No. 1, 35-81(Sep 1972).

Space densities for O-F7 type stars were derived for a Monoceros region ($l^{II} = 230°$, $b^{II} = +2°$) and the behavior of the interstellar extinction was obtained. The results together with those by McCuskey and Bok and collaborators form the basis for a discussion of the distribution of stars and interstellar matter in the longitude section 185° to 215°. The open cluster NGC 2264, which is situated within the region, is briefly discussed. (auth)

3447 RADIATION-DRIVEN EFFLUX AND CIRCULATION OF DUST IN SPIRAL GALAXIES. Chiao, R. Y. (Univ. of California, Berkeley). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 361-73(1972).

Dust grains, which carry a net electric charge, may be driven out of the galactic disk along magnetic field lines by radiation pressure of starlight. Large-scale mixing or escape of the dust occurs along closed loops or open field lines, respectively. Mixing and escape also occur by means of instabilities of the galactic disk caused partially by radiation pressure on the grains. These processes could lead to the occurrence of a significant amount of intergalactic extinction. (auth)

3448 SURVEY OF LINEAR POLARIZATION AT 1415 MHz. III. METHOD OF REDUCTION AND RESULTS FOR THE GALACTIC SPURS. Spoelstra, T. A. Th. (Leiden Observatory). Astron. Astrophys., Suppl. Ser.; 7: No. 2, 169-230(Oct 1972).

1415 MHz observations are presented of linear polarization of the galactic background radiation in the direction of the North Polar Spur, the Cetus Arc, and Loop III. The reduction of the observations is discussed; the discussion includes a comparison

of the instrumental effects of two feedhorns. The results are presented in tabular form. (auth)

3449 RADIO CONTINUUM EMISSION AT 21 CM NEAR STEPHAN'S QUINTET. Allen, R. J.; Hartsuiker, J. W. (State Univ., Groningen, Netherlands). Nature (London); 239: No. 5371, 324-5(6 Oct 1972).

An area about one degree square near Stephan's Quintet of galaxies was observed with the Westerbork Synthesis Radio Telescope at 21.2 cm. The measurements comprised 12 h registrations at 40 interferometer spacings from 36 to 1,440 m in intervals of 36 m, and the observations were Fourier transformed to produce a map of the radio brightness of the region with a synthesized beam 25 arcs wide at the half-power points. The radio features detected consisted of an unresolved source located very near the nucleus of the spiral galaxy. NGC 7319 and an unusual approximately semicircular arc of emission appeared partially to envelope this galaxy. The nuclear source in NGC 7319 had a flux density of $28 \pm 5 \times 10^{-29} W/m^2/Hz$. The association between such an arc of emission with a galaxy appears to be unique. Several possible interpretations of the radio arc are offered. Perhaps the most attractive model involves the radio emission occurring in a galactic bow shock that arises from the gravitational accretion of gas by NGC 7319 as it moves through the group of galaxies, the arc-shaped geometry occurring in a natural way from the structure of the bow shock itself. Observations of the spectrum and linear polarization of the radio emission are under way to test the models. (UK)

3450 GRADIENT-SLOPE DIAGRAM FOR GALAXIES AND QUASARS. Vandekerkhove, Edgard. Bull. Cl. Sci., Acad. Roy. Belg.; 57: No. 11, 1233-42(1971). (In French).

For the radiation of galaxies and quasars, at rest or with low radial speed, and for the spectral regions of 0.50 μ and 0.34 μ, a plane diagram is presented; its rectangular coordinates are the spectrophotometric gradients or the corresponding slopes of the continuous background which is deduced from the curve of the absolute flux densities. The points relative to three compact Zwicky galaxies are well situated between those of 24 quasars, nine Seyfert galaxies, M 31, M 32, and eight elliptical giant galaxies. The situation of all these objects is well marked relative to the blackbody and to radiators such as $F_\nu = k\nu^{-\alpha}$ and $F = e^{-\nu/\nu_0}$. The gradients of the point nucleus of the Seyfert galaxy NGC 4151 are similar to those of the quasar 3C 273, whereas the gradients of a central region, extending from 10", are much higher than those of an elliptical galaxy. The diagram is completed by the indication of the difference of the absolute flux densities for the regions considered. The Balmer discontinuities measured are all negative; their mean value is −0.08 for five quasars and it is −0.07 for the Seyfert galaxy NGC 7469. The ensemble of the signs of the slopes, the differences of the absolute flux densities, and the differences of the Balmer discontinuity characterize the form of the continuous background of the absolute flux densities in this spectral region. (tr-auth)

3451 APPROXIMATE FORM OF THE THIRD INTEGRAL IN THE GALAXY. Perek, L. (Astronomical Inst., Prague). Bull. Astron. Inst. Czech.; 23: No. 5, 246-62(1972).

An approximate form of the third integral, based on a potential separable in eccentric elliptic coordinates, is proposed for the Galaxy at the distance of the Sun and for velocity components up to 30 km/sec. The approximation is accurate to about 10^{-3}. Formulae are given for the third integral, for the perigalactic and apogalactic distances, for the maximum height of the orbit above the plane of symmetry, for the periods in z in R, and in ϑ. No resonances seem to appear. The influence of the value of the integral of area is discussed. (auth)

3452 INCLINATION CORRECTIONS TO THE OPTICAL LUMINOSITIES AND DIAMETERS OF GALAXIES. Tully, R. B. (Univ. of Maryland, College Park). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 35P-40P(1972).

The results of an investigation by Heidmann, Heidmann, and de Vaucouleurs (Mem. R. Astr. Soc.; 75: 85(1972)) on the effects of inclination on observed magnitudes and diameters of galaxies are questioned. It is concluded that corrections must be made for internal absorption in external galaxies and that diameter corrections do not have to be made. (auth)

Cosmology

Refer also to abstracts 3336 and 3911.

3453 ARE GALAXIES FORMED BY MATERIAL FLOWING OUT OF SINGULARITIES? Bahcall, J. N.; Joss, P. C. (California Inst. of Tech., Pasadena). Comments Astrophys. Space Phys.; 4: No. 4, 95-9(1972).

The observational consequences of the hypothesis that some or all galaxies or quasars are formed by material flowing out of a singularity are described. No attempt is made to fit the mathematical models into an overall scheme for the evolution of the Universe. If the outflow hypothesis were shown to be correct for some extragalactic systems, the result could be interpreted as undermining the conventional cosmological picture in which the Universe as a whole is imagined to evolve through the expansion of a single coherent system. (W.D.M.)

3454 ROTATING BLACK HOLES: SEPARABLE WAVE EQUATIONS FOR GRAVITATIONAL AND ELECTROMAGNETIC PERTURBATIONS. Teukolsky, Saul A. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 29: No. 16, 1114-18(16 Oct 1972).

Separable wave equations with source terms are presented for electromagnetic and gravitational perturbations of an uncharged, rotating black hole. These equations describe the radiative field completely, and also part of the nonradiative field. Nontrivial, source-free, stationary perturbations are shown not to exist. The barrier integral governing synchrotron radiation from particles in circular orbits is shown to be the same as for scalar radiation. Future applications (stability of rotating black holes, "spin-down," superradiant scattering, floating orbits) are outlined. (auth)

3455 CHAOS IN COSMOLOGY. Jones, B. T. J.; Peebles, P. J. E. Comments Astrophys. Space Phys.; 4: No. 4, 121-8 (1972).

The idea that the structure in the Universe originated from some primordial vortical motion has had a remarkably long history and central role in cosmological speculation. This speculation is briefly summarized along with some of the simple constraints thought to be cause for serious concern with primeval turbulence in a hot big bang model. (W.D.M.)

3456 SOME PROPERTIES OF A UNIFORM FLUID SPHERE IN GENERAL RELATIVITY. Banerjee, A. (Univ., Paris). J. Phys., A (London); 5: No. 9, 1305-11(Sep 1972).

A method is presented to obtain a class of exact solutions for uniform fluid spheres surrounded by empty space. It is shown that in some cases there is a reversal in the motion of contraction or expansion of the sphere, while in other cases there is no bouncing at all. (auth)

3457 NOTE ON ENERGY EXTREMAL PROPERTIES FOR ROTATING STARS IN GENERAL RELATIVITY. Katz, J. (Hebrew Univ., Jerusalem). J. Phys., A (London); 5: No. 6, 781-5(Jun 1972).

Using Komar's localized energy and spin conserved vectors associated with the Killing fields of a stationary axisymmetric universe, a covariant identity is derived which describes in terms of variations of fields and matter functions a perfect fluid in general relativity, exhibiting in a clear and straightforward way a variety of known extremal theorems, or analogous ones, for energy or entropy. (auth)

3458 TWO FLUID COSMOLOGICAL MODEL. Knight, Wayne R. Washington, D. C.; George Washington Univ. (1972). 159p. University Microfilms Order No. 72-25,056.

Thesis.

This study extends the two fluid cosmological models developed by Tolman in the period from 1929 to 1936 to include the simplest form of interaction between matter and radiation, viz., the annihilation of mass to form radiation. The only radiative processes considered in this study are those occurring within the stellar systems which are associated with the transformation of hydrogen into iron. (TSS) (Diss. Abstr. Int., B)

3459 BLACK HOLES AND TEMPORAL ORDERING. Peat, F. D. (National Research Council of Canada, Ottawa). Nature (London); 239: No. 5372, 387(13 Oct 1972).

It is stated that within a system isolated from the remainder of the Universe asymmetry of temporal order may not be maintained, and the system will reach a state of dynamic equilibrium. In this connection a black hole provides such a situation, since world lines and radiation may not escape from a system that has fallen through its Schwarzschild radius. It is, however, possible for exterior particles and radiation to enter the hole, and some of its rotational energy may be extracted from the ergosphere. It would appear that dissipative processes, with the attendant spontaneous increase in "disorder," are not possible within the hole, and it seems reasonable to question the assumption of a fixed temporal direction for the collapse of a black hole and the issue of the final state, and furthermore the meaning of the terms "time" or "proper time" as applied to processes within a black hole may be questioned. Attention is drawn to one of the classical assumptions

as to the nature of "time" that has remained unexamined in the light of quantum physics and general relativity. (UK)

3460 POLARIZATION OF GRAVITATIONAL SYNCHROTRON RADIATION. Khalilov, V. R.; Loskutov, Yu. M.; Sokolov, A. A.; Ternov, I. M. (Moscow State Univ.). Phys. Lett.; 42A: No. 1, 43-4(6 Nov 1972).

In the linear approximation it is shown that the gravitational radiation induced by ultrarelativistic charges, moving in a magnetic field or in the field of a circularly polarized electromagnetic wave, does not have the primary linear polarization contrary to the case of the electromagnetic synchrotron radiation. (auth)

3461 COSMIC EFFECTS OF GRAVITATIONAL WAVES. Isaacson, R. A. (Illinois Inst. of Tech., Chicago); Winicour, J. Nature (London); 239: No. 5373, 447-8(20 Oct 1972).

The possibility that gravitational radiation is of primordial origin has been considered by Kafka (Nature 226: 436 (1970)), who used the Friedmann equations to determine its effect on the evolution of the cosmos, and found that if this were so that lifetime of the Universe would be shortened to 3.3×10^9 yr, leading to the conclusion that the observed wave pulses cannot be remnants of the "big bang." If the observed radiation is of galactic rather than cosmological origin then, since the Galaxy is typical, it must be assumed that all galaxies are radiating gravitationally at roughly the same rate, leading to a large total amount of radiation that should be included in the gravitational dynamics of the expanding Universe. The present author constructed a model incorporating the galactic emission of gravitational waves in the later phases of cosmological evolution, and examined the resultant shortening of the lifetime of the Universe. The gravitational radiation is described in terms of two parameters, f_0 and n. The first parameter gives the present fractional conversion rate of matter into gravitational waves, and the second parameter determines the profile of the mass loss rate as a function of time. To evaluate the lifetimes numerically two additional observational parameters are required—the present energy density E_0 and the Hubble constant H_0. It was found that gravitational radiation shortens the calculated lifetime by a factor of at least 2. In addition to its effects on the time scale of the cosmos, the radiation has another important consequence; the present energy density of gravitational waves is a factor of about 20 larger than E_0, so that relatively small matter densities lead to closed universes. It is concluded that gravitational radiation, even though not a remnant of the big bang, is of considerable importance to cosmological models. (UK)

Planetary Phenomena

3462 METEOROID INFLUX AND THE MAINTENANCE OF THE SOLAR SYSTEM DUST CLOUD. Hughes, D. W. (Univ. of Sheffield, Eng.). Planet. Space Sci.; 20: No. 11, 1949-59(Nov 1972).

The total mass influx onto the Earth's surface has been calculated over the mass range 10^{-13} to 10^{10} g by using cumulative influx rate data. Interpolation formulae have been fitted to this data and the resulting influx is found to vary between 3×10^8 and 5×10^{13} g (Earth surface)$^{-1}$ yr^{-1} depending on which data are used to obtain the formulae. By considering the latest measurements of comet masses and estimates for the rate of cometary decay, the mass influx to the solar system dust cloud has been calculated. Considering the processes responsible for removing particles from the cloud it is concluded that, if the cloud is to remain in equilibrium, the influx to the Earth's surface must be about $10^{8.7 \pm 0.3}$g (Earth surface)$^{-1}$ yr^{-1}. (auth)

3463 CONTRIBUTION OF SPATIAL CURVATURE TO THE PERIHELIC PRECESSION. Arjun, T. T. (Visva-Bharati Univ., Santiniketan, India). Chin. J. Phys. (Taiwan); 10: No. 2, 110-13 (Oct 1972).

The contribution of spatial curvature to the perihelic precession in Einstein's theory is discussed with reference to minor but important discrepancies found in standard literature. The contribution from spatial curvature alone is found to depend upon the coordinate system chosen. However, the over-all precession due to combined space-time curvature and specified by the field equations is unique. (auth)

PHYSICS (ATMOSPHERIC)

Auroral and Ionospheric Phenomena

Refer also to abstracts 3368 and 3495.

3464 (AD–740177) SUPERSONIC AND SUBSONIC MEASUREMENTS OF MESOSPHERIC IONIZATION. Nickell, L. (Pennsylvania State Univ., University Park. Ionosphere Research Lab.). 1 Nov 1971. 32p. (PSU-IRL-SCI-377; AROD-7430:5-E). NTIS.

An Arcas rocket-parachute system was used at night to compare supersonic and subsonic ionization measurements below 75 km. A hemispherical nose-tip probe was used on ascent and a parachute-borne blunt probe was employed on descent to measure polar conductivities, which were due entirely to positive and negative ions. (auth) (GRA)

3465 OBSERVATIONS OF SIMULTANEOUS AURORAL D AND E LAYERS WITH INCOHERENT SCATTER RADAR. Hunsucker, R. D.; Bates, H. F.; Belon, A. E. (Univ. of Alaska, College). Nature (London) Phys. Sci.; 239: No. 94, 102-4 (16 Oct 1972).

Electron-density profiles are shown for the disturbed auroral ionosphere in the height range 80 to 150 km obtained by the incoherent scatter technique using the Incoherent Scatter Radar located at Chatanika, Alaska. The records show distinct D and E layers, and such separate layers could only have been caused by a precipitation of particles having a binodal energy spectrum. The auroral situation observed was characteristic of the behavior that occurs on active nights during the recovery phase of an auroral substorm. Fluxes were calculated, and the results, together with radar measurements and concurrent radio and optical observations of the aurora, suggest that, at times during the recovery phase of an auroral substorm, the particle precipitation consists of spatially discrete fluxes of low-energy electrons (~5 keV) embedded in a widespread temporally varying high energy electron flux (~70 keV). This is consistent with satellite and other measurements. Other observed features are noted. Vertical incidence ionosonde observations were made preceding and during the radar observations. Data were also obtained with a 30 MHz riometer, and the good agreement between the absorptive values measured with the riometer and calculated from the electron density profiles suggests that 70 keV electrons were precipitated over a large area of the ionosphere. (UK)

3466 EFFECT OF MOLECULAR OXYGEN AND TEMPERATURE ON THE N_2 FIRST POSITIVE BANDS IN THE NITROGEN AFTERGLOW. Ghosh, S. N.; Gupta, S. K. (Univ. of Allahabad, India). Indian J. Phys.; 46: No. 1, 18-27(Jan 1972).

The effect of addition of molecular oxygen and the increase of temperature on the intensity of the (11,7) band of the N_2 first positive system in the nitrogen afterglow have been studied in a dynamical flow system. It is proposed that the decrease of intensity of the afterglow on addition of O_2 is due to consumption of Na atoms. The decrease of intensity because of the rise of temperature is proposed to be due to the increase in value of the deactivation rate coefficient of $N_2(B\ ^3\Pi_g)$ molecules by normal N_2 molecules. (auth)

3467 DISTRIBUTION OF THE AMPLITUDE OF VERTICAL RADIO PULSES RETURNED FROM THE IONOSPHERE. Khastgir, S. R. (Visva Bharati Univ., Santiniketan, India). Indian J. Phys.; 46: No. 1, 28-31(Jan 1972).

In a previous paper Khastgir et al., (Radio Science, 3: 535 (1968)) gave a possible explanation of the double-peak amplitude distribution observed by them for the vertically directed radio pulse returned from the sporadic-E region in terms of the double layer occasionally formed in that region (Seddon 1962). This explanation is, however, not tenable in cases of reflection from the normal E and F layers. In the present paper, the amplitude probability distribution for normal E and F echoes is discussed. When a radio pulse directed vertically upwards enters an ionospheric layer, and if the frequency of the radio wave is less than the critical penetration frequency of the layer, the ordinary and extraordinary components are reflected at two different heights within the layer. At these reflection heights the rms values of the random components, scattered from ionospheric irregularities at these heights, and their characteristics and amplitudes of the steady components reflected from the two heights and their characteristics are different. Taking the statistical formula of Rice (1944, 1945), a double peak is therefore expected in the amplitude distribution curve, especially in the case of F layer, since the two different reflection heights in that layer are not very close together. (It is, however, assumed that they are close enough for the two magneto-ionic components to remain unresolved.) In the case of reflection from the normal E layer, where the two reflection heights are very near to each other, the double-peak distribution is much less possible. Since the sporadic-E region is very thin, it is believed that the double-peak distribution may be interpreted in terms of the double layer that is occasionally observed in that region. (auth)

3468 POSSIBLE CORRELATION BETWEEN TOTAL ATMOSPHERIC OZONE CONTENT AND IONOSPHERIC D-REGION RADIO-WAVE ABSORPTION. Samanta, S. (Bose Inst., Calcutta). Indian J. Phys.; 46: No. 1, 32-41(Jan 1972).

It has been shown that the general trend of variation of the monthly standard deviation of total ozone contents over Kodaikanal is grossly followed by the trend of variation of the standard deviation of the D-region radio wave absorption at 2 MHz over Ceylon. The month to month correlation coefficients show both positive and negative values. Various factors have been discussed to explain the probable causes of the 46% of positive correlations, 27% of negative correlations, and 27% cases of no correlation. It has been concluded that the positive correlation is the actual condition of state. (auth)

3469 POSSIBILITY OF O III λ304-A EMISSIONS IN THE EXTREME-ULTRAVIOLET AIRGLOW. Carlson, R. W. (Univ. of Southern California, Los Angeles). J. Geophys. Res.; 77: No. 31, 6282-3(1 Nov 1972).

Measurements of euv airglow emissions in the 200- to 400-A region may contain a significant contribution from doubly ionized atomic oxygen ions, a species that has been found in the ionosphere and has a resonance line nearly coincident with the He^+ line. The He II resonance line occurs at λ303.782 A, whereas the $2p^2\ ^3P_2 - 2p3d\ ^3P_2^0$ transition of O^{++} occurs at λ303.799 A. When it is assumed that the solar He^+ line is broadened over the wavelength difference of 17 mA, O^{++} ions can absorb and re-emit the solar He^+ line. The importance of O^{++} emissions in relation to He^+ in the terrestrial atmosphere can be assessed by a comparison of the respective column densities appropriate for the observational conditions and the oscillator strengths of the two transitions. Although the O^{++} ion is not widely observed, (possibly owing to the instrumental differences or large temporal or spatial variations) and the available results show large variations, the author contends that the O^{++} density may be comparable to the He^+ density. (J.C.W.)

3470 ENERGETIC METASTABLE MOLECULAR OXYGEN AS A SOURCE OF IONIZATION IN THE D REGION. Norton, R. B.; Reid, G. C. (National Oceanic and Atmospheric Administration, Boulder, Colo.). J. Geophys. Res.; 77: No. 31, 6287-90(1 Nov 1972).

Possible new sources of O_2^+ in the D region were considered. Two critical excitation energies considered are first, at 1.9 eV the O_2 molecule can be ionized by the intense Lyman-α line, with a photon energy of 10.2 eV, and secondly, at 2.85 eV it can suffer an exothermic charge exchange reaction with NO^+, whose ionization potential is 9.25 eV. The known electronic levels of O_2 are graphically shown. The study includes the vibrationally excited O_2 molecules in the ground $^3\Sigma_g$-state, where the vibrational quantum number must be ≥ 11 for Lyman-α ionization and ≥ 17 for exothermic charge exchange with NO^+. (J.C.W.)

3471 AURORAL X-RAY AND CONJUGATE IONOSPHERIC ABSORPTION OBSERVATIONS OF AN ELECTRON PRECIPITATION EVENT ACCOMPANYING A SUDDEN IMPULSE IN THE GEOMAGNETIC FIELD. Barcus, J. R. (Univ. of Denver); Brown, R. R.; Karas, R. H.; (and others). J. Geophys. Res.; 77: No. 31, 6294-7(1 Nov 1972).

A sudden impulse precipitation was observed with an electron bremsstrahlung detector at 9-g/cm^2 atmospheric depth at about 1130 LT by R. R. Brown (J. Geophys. Res., 72: 2448(1967)). The geomagnetic variation observed at a site near the x-ray detector was a si of +955 γ in H, reaching its peak level in approximately 2 min and returning to its predisturbance level 9 min after onset. The x-ray flux accompanying this intense disturbance was weak in comparison with that from other forms of electron precipitation. The x-ray spectra were relatively soft considering the fact that auroral x-ray fluxes harden toward local noon, and the x-ray intensity variations were relatively unstructured in time. A second event is reported for Feb. 4, 1969. Observations were ob-

tained near the dawn meridian and include both bremsstrahlung data at balloon altitude and ionospheric absorption of cosmic radio noise. This event, in contrast to the first observation of the si electron precipitation in the auroral zone, shows rapid variations in the electron flux; in addition, riometer observations at conjugate sites (Reykjavik, Iceland, and Syowa, Antarctica) show that the electron precipitation was essentially similar and simultaneous at this longitude. (J.C.W.)

3472 REVISED CALCULATIONS OF F-REGION AMBIENT ELECTRON HEATING BY PHOTOELECTRONS. Swartz, W. E.; Nisbet, J. S. (Pennsylvania State Univ., University Park). J. Geophys. Res.; 77: No. 31, 6259-61(1 Nov 1972).

Photoelectron energy degradation calculations were performed with the improved analytic expression for the photoelectron to ambient electron energy transfer rate given by Swartz, et al. (1971). On the basis of these calculations, two curves for the mean energy transferred per photoelectron to the ambient electrons are given as functions of the electron–neutral density ratio. One curve is based on the primary-photoelectron production rate, and the other on the total production rate. When the electron–neutral density ratio falls between 10^{-6} and 10^{-3}, these curves provide good estimates of the electron heating rates over a wide range of F-region conditions. The large differences between the energy transfer rate coefficients used in these calculations and the Butler and Buckingham (1962) form used in most previous investigations do not result in a major modification of the ambient electron heating rate. (auth)

3473 Pc MICROPULSATIONS WITH DISCRETE LATITUDE-DEPENDENT FREQUENCIES. Rostoker, Gordon; Samson, J. C. (Univ. of Alberta, Edmonton). J. Geophys. Res.; 77: No. 31, 6249-53(1 Nov 1972).

An example of continuous Pc micropulsations with discrete, latitude-dependent frequencies in the H (north–south) components is presented. These pulsations were recorded simultaneously at seven ground-based magnetometer stations ranging in geomagnetic latitude from 58.5° to 77.7°N. The pulsations exhibited four discrete spectral peaks in the H components (f = 14.7, 6.6, 4.1, and 1.3 mHz; T = 68, 152, 244, and 780 sec); each peak dominated in a narrow latitudinal range, and the dominant frequency decreased with increasing latitude. The latitudinal change in the frequency of the H component suggests that these Pc pulsations may be caused by poloidal modes with extreme longitudinal asymmetries. Conversely, the narrow L-shell localization of the discrete frequencies suggests that the plasma densities in the magnetosphere may have had a lamellar structure at the time these pulsations occurred. (auth)

3474 EXCITATION OF THE HERZBERG BANDS OF O_2 IN LABORATORY AFTERGLOW AND NIGHT AIRGLOW. Degen, V. (Univ. of Alaska, Fairbanks). J. Geophys. Res.; 77: No. 31, 6213-18(1 Nov 1972).

Relative vibrational populations of the metastable O_2 $A^3\Sigma_u^+$ molecule were calculated from a statistical equilibrium model and compared with vibrational populations determined spectroscopically in an oxygen–argon afterglow at pressures of 5 to 120 torrs and with the nightglow populations obtained previously. The model assumes the three-body recombination process to be the principal excitation mechanism and vibrational relaxation to be the principal collisional deactivation mechanism. A close fit is obtained with both sets of data when the excited molecule is treated as an anharmonic oscillator during the relaxation process; thus the peculiar distributions of band intensities observed in the Herzberg band spectra ($A^3\Sigma_u^+ - X^3\Sigma_g^-$) are the consequence of the strongly anharmonic character of the $O_2A^3\Sigma_u^+$ molecule rather than of some other processes. Although the formulation provides for collisional quenching, the data are not as yet sufficiently complete to make a firm estimate. (26 references) (auth)

3475 MONTE CARLO SIMULATION OF D-REGION SAMPLING. Long, R. L. Jr. (Sandia Labs., Albuquerque, N. Mex.); Vogenitz, Frank W. J. Geophys. Res.; 77: No. 31, 6181-93(1 Nov 1972).

Monte Carlo calculations were made of the aerodynamic properties of rocket payload designs that might be suitable for measuring the composition of the D region of the ionosphere. A conical design with the sampling orifice at its tip was used for most of the calculations. Variations were made in the altitude parameters, the cone angle, and the angle of attack. The molecules in the computations were classified as undisturbed free-stream molecules or as molecules that collided with the surface of the payload or with another molecule that had previously collided with the payload. This classification enabled determination of the fraction of the gas entering the sampling orifice that might have been changed from its ambient state by the influence of the payload. The results indicate that a cone half-angle of $\leq 25°$ would result in $\geq 90\%$ of the sample being undisturbed free-stream molecules representative of the composition of the ambient atmosphere. For the blunt configuration used for D-region measurements so far, only about 8% of the sample would be certain to be representative of the composition of the ambient atmosphere. (26 references) (auth)

3476 ATMOSPHERIC HELIUM AND GEOMAGNETIC FIELD REVERSALS. Sheldon, W. R.; Kern, J. W. (Univ. of Houston, Tex.). J. Geophys. Res.; 77: No. 31, 6194-6201(1 Nov 1972).

The problem of the Earth's helium budget is examined in the light of recent work on the interaction of the solar wind with nonmagnetic planets. It is proposed that the dominant mode of helium (^4He) loss is ion pumping by the solar wind during geomagnetic field reversals, when the Earth's magnetic field is very small. The interaction of the solar wind with the Earth's upper atmosphere during such a period is found to involve the formation of a bow shock. The penetration altitude of the shock-heated solar plasma is calculated to be about 700 km, and ionization rates above this level are estimated for a cascade ionization (electron avalanche) process to average 10^9 ions cm^{-2} sec^{-1}. The calculated ionization rates and the capacity of the solar wind to remove ionized helium (^4He) from the upper atmosphere during geomagnetic dipole reversals are sufficient to yield a secular equilibrium over geologic time scales. The upward transport of helium from the lower atmosphere under these conditions is found to be adequate to sustain the proposed loss rate. The implications of the differential ion pumping for other constituents are outlined for the Earth's atmosphere. A pumping rate for Venus is inferred, which is sufficient to remove the hydrogen associated with about 30 atm of water from the upper Cytherian atmosphere during geologic time. The terrestrial ^3He budget is strongly affected both by this mechanism and by enhanced production by cosmic rays during the depression of the geomagnetic field before and after a reversal. (37 references) (auth)

3477 MEASUREMENTS OF $O(^1D)$ QUENCHING RATES IN THE F REGION. Sipler, D. P.; Biondi, M. A. (Univ. of Pittsburgh). J. Geophys. Res.; 77: No. 31, 6202-12(1 Nov 1972).

Determinations of the quenching of $O(^1D)$ atoms by N_2 and O_2 molecules in the F region have been made from observations of 6300-A night-glow intensity enhancements produced by the Platteville 1.6-MW transmitter. The heating of F region electrons near the point of reflection of the rf wave leads to electron impact excitation of oxygen atoms to the $O(^1D)$ state. It is shown that at the lower altitudes the resulting region of enhanced 6300-A emission is localized to the region of electron energy absorption. At 225 km the measured time constants for intensity build-up following transmitter turn on and for intensity decay following turn off are identical and equal to (13 ± 1) sec. Time constants of 30 to 80 sec are found for the altitude range 260 to 300 km. The quenching frequency obtained at 225 km, referred to the altitude 120 km, is equal to (19 ± 2) sec^{-1}, in agreement with less direct ionospheric determinations. The deduced quenching coefficient for the whole altitude range, 225 to 300 km, is $k_q = (6^{+4}_{-3}) \times 10^{-11}$ cm^3 sec^{-1} at 950°K, in good agreement with laboratory data. (26 references) (auth)

3478 SOME POLARIZATION CHARACTERISTICS OF Pc 3–5 MICROPULSATIONS OBSERVED AT COLOMBO, CEYLON. Kannangara, M. L. T. (Univ. of Ceylon, Colombo). J. Geophys. Res.; 77: No. 31, 6161-7(1 Nov 1972).

Some polarization characteristics of geomagnetic micropulsations in the period range 20 to 600 sec recorded about 200 km south of the geomagnetic equator in Colombo, Ceylon, at a distance of about half a mile from the western coastline of Ceylon, which runs approximately N–S are studied. It is found that the magnetic vector of the micropulsations lies almost entirely in the plane of the magnetic meridian and that the inclination of the vector to the horizontal increases as the period increases. This increase in inclination with period is very gradual at nighttime but is much more pronounced during daytime. The buildup and decay of $\Delta Z/\Delta H$ during daytime seem to follow the buildup and decay of the E region of the ionosphere. It is suggested that these polarization characteristics support the view that the micropulsations observed in Colombo are the induction effects of fluctuating current systems in the ionosphere flowing in the E–W direction in the region of the geomagnetic equator, the currents being in the E layer during daytime and in the F layer at nighttime. (auth)

3479 LATITUDE-DEPENDENT CHARACTERISTICS OF HIGH-LATITUDE Pc 4 AND Pc 5 MICROPULSATIONS. Samson, J. C.; Rostoker, Gordon (Univ. of Alberta, Edmonton). J. Geophys. Res.; 77: No. 31, 6133-44(1 Nov 1972).

Pc-4 and Pc-5 micropulsation events ($1 < f < 22$ mHz, $45 < T < 1000$ sec) recorded at a line of magnetometer stations extending

from 58.5 to 78°N corrected geomagnetic latitude were analyzed in an attempt to detect any apparent latitudinal characteristics of these pulsations. The three-component data from each station were subjected to a generalized, three-dimensional spectral analysis in which the polarizations and station-to-station phases were determined. Although each individual Pc-4 or Pc-5 pulsation train usually had the same frequency at all latitudes, the latitude of the intensity peak generally decreased as the frequency of the pulsations increased, fitting a relation of the form $T = f^{-1} = C \sec^2 \phi$, where T is the period, f is frequency, ϕ is latitude, and C is a constant depending on diurnal effects. In addition, many Pc 4 and 5 events had evident latitudinal reversals in the horizontal sense of polarization, the latitude of the reversal decreasing as the frequency of the pulsations increased. The existence of distinct Pc-4 and Pc-5 spectral bands may be the result of the preferential coupling of the pulsational energy into magnetic shells near the auroral oval and near the plasmapause. (auth)

3480 THREE-DIMENSIONAL POLARIZATION CHARACTERISTICS OF HIGH-LATITUDE Pc 5 GEOMAGNETIC MICROPULSATIONS. Samson, J. C. (Univ. of Alberta, Edmonton). J. Geophys. Res.; 77: No. 31, 6145-60(1 Nov 1972).

In 1969 and 1970, a line of magnetometer stations was operated in western Canada between 58.5° and 77.7°N corrected geomagnetic latitude and within 2° of 302°E correct geomagnetic longitude. This paper deals with the three-dimensional polarization characteristics of low-frequency (f < 4 mHz, T > 250 sec) Pc-5 geomagnetic micropulsations recorded at these stations. The center of activity of these pulsations follows the auroral oval during the whole day. The early morning (0200–1000 local geomagnetic time) has the greatest number of pulsations, with almost circular polarization in the horizontal plane, whereas the afternoon normally has few sinusoidal pulsations and almost linear polarization in the direction of magnetic north. A reversal in the sense of polarization in the horizontal plane, occurring between 1130 and 1230 local geomagnetic time, suggests that the Pc-5 events derive their energy from a Kelvin–Helmholtz instability at the magnetopause. A latitudinal change in the sense of polarization, occurring near the latitude of the peak intensity, indicates that the energy of the pulsations may be distributed in a resonant hydromagnetic mode within the Earth's inner dipole field or that field lines at high latitudes ($\lambda > 70°$) may pass into the magnetosheath. The vertical components of the Pc events are likely caused by spatial gradients in the ionospheric currents associated with the pulsations. During part of the pulsation cycle, strong shear currents flow to the east and the west in the ionosphere, giving a large vertical magnetic field near the latitude of the peak in the intensity of the horizontal components. (48 references) (auth)

3481 SIMULTANEOUS ELECTRIC-FIELD MEASUREMENTS ON NEARBY BALLOONS. Mozer, F. S. (Univ. of California, Berkeley). J. Geophys. Res.; 77: No. 31, 6129-32(1 Nov 1972).

Electric-field payloads were flown simultaneously on two balloons from Great Whale River, Canada, on September 21, 1971, to provide data at two points in the upper atmosphere that differed in altitude by more than one atmospheric density scale height and in horizontal position by 30 to 140 km. The altitude dependencies in the two sets of data prove conclusively that the vertical electric field at balloon altitudes stems from fair-weather atmospheric electricity sources and that the horizontal fields are mapped down ionospheric fields, since the weather-associated horizontal fields were smaller than 2 mV/m. The differences between the two sets of horizontal-field data require the occasional appearance of spatially confined order-of-magnitude enhancements of the ionospheric electric field having scale sizes of 15 to 100 km. (auth)

3482 ISIS 1 OBSERVATIONS OF THE HIGH-LATITUDE IONOSPHERE DURING A GEOMAGNETIC STORM. Whitteker, J. H. (Communications Research Centre, Ottawa); Brace, L. H.; Burrows, J. R.; (and others). J. Geophys. Res.; 77: No. 31, 6121-8(1 Nov 1972).

The Isis-1 satellite has made measurements of several ionospheric and related parameters, and the results of the various measurements have been compared in detail for two north transpolar passes during the geomagnetic storm of February 3, 1969. Simultaneous measurements were made of local electron and ion densities and temperatures, electron density between the satellite and the peak of the F layer, radio noise, and particle fluxes over a wide energy range extending down to 10 eV. Several features of the ionosphere (in particular, enhancements of radio noise, scale height, and plasma temperatures) appear to be due to soft-particle (100 to 1 keV) precipitation, which is related to magnetospheric structure as delineated by the observation of more energetic particles. The magnetosheath particles precipitating on the dayside of the polar cap are particularly effective. Although soft particles appear to exert an important influence on the topside ionosphere, they alone cannot account for the observed distribution of ionization, and ionization transport may also be important. (28 references) (auth)

3483 ANGULAR DISTRIBUTIONS OF AURORAL ELECTRONS IN THE ENERGY RANGE 0.8 TO 16 keV. Paschmann, G. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.); Johnson, R. G.; Sharp, R. D.; Shelley, E. G. J. Geophys. Res.; 77: No. 31, 6111-20(1 Nov 1972).

Auroral particle fluxes have been measured by detectors aboard the low-altitude, polar-orbiting satellite OVI 18. Electron pitch-angle distributions in the energy range 0.8 to 16 keV are presented for a 3-month period in 1969. The distributions at all energies were found to be predominantly isotropic for intensities above a few times 10^6 $(cm^2 \text{ sec ster keV})^{-1}$, independent of latitude and geomagnetic conditions. This result suggests that strong pitch-angle diffusion is almost always operating on auroral field lines at higher electron intensities. At lower intensities and energies above a few keV, fluxes in the loss cone on the average were found to decrease with decreasing pitch angles, indicating an intensity dependence of the diffusion strength. Occasionally field-aligned angular distributions were observed at electron energies below a few keV. These anisotropies are discussed on the basis of parallel electric fields in conjunction with pitch-angle scattering. (auth)

3484 FURTHER COMMENTS ON A PARALLEL STUDY OF 6300 A AIRGLOW EMISSION AND IONOSPHERIC SCINTILLATION. Mullaney, H. (Sanders Associates, Nashua, N. H.); Papagiannis, M. D.; Noxon, J. F. Planet. Space Sci.; 20: No. 11, 1982-4(Nov 1972).

The interpretation, given in a previous paper (Mullaney, Papagiannis, and Noxon, 1972) of the power spectrum for fluctuations in 6300-Å nightglow during periods of enhanced ionospheric radio scintillation is revised; the physical processes responsible for the fluctuations are discussed further. (auth)

3485 GEOMAGNETIC FIELD VARIATIONS CAUSED BY CHANGES IN THE QUIET-TIME SOLAR WIND PRESSURE. Verzariu, P. (Johns Hopkins Univ., Silver Spring, Md.); Sugiura, M.; Strong, I. B. Planet. Space Sci.; 20: No. 11, 1909-14(Nov 1972).

Solar-wind data from the Vela 2A and 2B satellites are compared with hourly D_{st} values for the period July 1964 to July 1965. During periods of positive D_{st} on magnetically quiet days the square root of the solar-wind pressure is found to be statistically linearly correlated to the hourly D_{st} values. This relation is in accordance with the theoretical expectation from the pressure balance at the magnetopause between the solar-wind plasma and the Earth's magnetic field. A constant of proportionality relating the two quantities is statistically determined. The average value for the proportionality constant agrees favorably with the theoretical value given by the Mead–Beard (1964) magnetosphere model. (auth)

3486 TRANSMISSION AND REFLECTION OF MAGNETOSPHERIC WHISTLERS IN THE IONOSPHERE AND LOWER EXOSPHERE AT HIGH LATITUDES. hayakawa, M.; Ohtsu, J. (Nagoya Univ., Japan). Planet. Space Sci.; 20: No. 11, 1895-1907(Nov 1972).

The propagation characteristics of downgoing magnetospheric whistlers through models of the lower exosphere are theoretically treated taking into account the Earth–ionosphere cavity. The situation is that the whistler mode propagates downward in the presence of the homogeneous magnetic field of vertical direction, and the lower exosphere is tentatively divided into several characteristic regions. The analytical expressions for the reflection and transmission coefficients, for these models, are derived, and their numerical values are shown for nighttime and daytime conditions. It is found that the most striking effects of the introduction of the Earth–ionosphere cavity are summarized as follows: (1) the reflection coefficients of magnetospheric whistlers become nearly unity for the usually encountered collision frequency in the lower ionosphere, and (2) there appear several characteristic minima in the transmission coefficients at certain frequencies, which are closely related with the spacing of the Earth–ionosphere cavity. These results will be useful in the study of the loss mechanism of vlf emissions as well as the whistler penetration problem. (auth)

3487 ENHANCED N_2 VIBRATIONAL TEMPERATURES IN THE THERMOSPHERE. Varnum, W. S. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Planet. Space Sci.; 20: No. 11, 1865-73(Nov 1972).

Vibrational temperatures of N_2 that are significantly greater than the gas kinetic temperature can influence chemical reaction rates and energy exchange processes in the thermosphere. The

continuity equation for the number density of vibrational quanta has been solved numerically using representative values for the source and loss terms for the cases of low and high solar activity. The interaction between N_2 vibration and thermal electrons, which has been neglected in previous calculations, has been included and shown to be important. Late afternoon maximum vibrational temperatures range from about 1700 to 3000°K from low to high solar activity. Corresponding noon values range from about 1500 to 2800°K. (auth)

3488 SUNRISE EFFECTS ON THE LATITUDINAL VARIATIONS OF TOPSIDE IONOSPHERIC DENSITIES AND SCALE HEIGHTS. Soicher, H. (Army Electronics Command, Ft. Monmouth, N. J.). Nature (London) Phys. Sci.; 239: No. 93, 93-5(9 Oct 1972).

Ionospheric sunrise represents the transition period between quasi-equilibrium conditions attained during the night and those attained during the day, and the arrival of sunrise is manifested by a rapid increase in electron temperatures and a less rapid increase in ion temperatures at all altitudes. In a plasma distribution that tends towards equilibrium a sharp increase in particle temperature results in a redistribution of the plasma, and in the topside ionosphere this is manifested by a diffusive flux of ions and electrons. An examination was made of a large number of ionograms obtained in 1963 from the Allouette-I topside sounder as the satellite traversed over the North American continent, experiencing local sunrise at ionospheric heights. Curves were obtained for smoothed mean electron density and scale height variations at fixed topside altitudes during local sunrise as a function of north geomagnetic latitudes—also for percentage deviations of electron densities at 550 km and scale heights at 450 and 750 km observed during satellite orbits at different nearby constant solar zenith angle ranges. An expression was obtained for the relationship between the electron and ion temperatures and the mean ion mass, assuming a static diffusive equilibrium; this expression showed that it is not possible to make unambiguous determinations of the electron and ion temperatures, its gradient, or the mean ion mass, since all three parameters are coupled. A method is described for ascertaining the solar zenith angle effects. A latitudinal variation of the electron densities and scale heights was apparent. The density at all topside altitudes decreased with increasing geomagnetic latitude up to about 60°N, after which it increased with latitude, and the variation of scale height with geomagnetic latitude was also striking. Interpretations of the results are offered. (UK)

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Refer also to abstracts 3365, 3373, 3436, 3485, and 3486.

3489 PERIODIC VARIATIONS IN GEOMAGNETIC K_p-DATA FROM 1932 THROUGH 1969. Hauska, H.; Dyring, E. (Uppsala, Univ.). pp 2036-42 of 12th International Conference on Cosmic Rays. Vol. 5. Hobart, Australia; International Union of Pure and Applied Physics (1971).

From 12th international conference on cosmic rays; Hobart, Australia (16 Aug 1971). See CONF-710807-(Vol. 5).

Long-run time series of geomagnetic activity were investigated by means of power spectrum analysis. The main periodicities in the range from 4 to 40 days were found to be at periods of about 27 and 13 days. For some years even significant 9 and 6-day periodicities have been found. Different types of elimination of disturbed periods were found to increase the power of the 13-day peak in comparison to the 27-day peak. It has also been determined that the year to year frequency variations decrease by replacing disturbed periods. A clear relation between the 27-day variation and recurrent geomagnetic storms was not discovered. No indication was found of a solar-activity-dependence of the existing periodic variations. However, a connection with the interplanetary magnetic field might exist during periods of stable interplanetary structure. (auth)

3490 MODIFICATION AND CRITICISM OF PETSCHEK'S MECHANISM. Priest, E. R. (National Center for Atmospheric Research, Boulder, Colo.). Mon. Notic. Roy. Astron. Soc.; 159: No. 4, 389-402(1972).

The mechanism proposed by Petschek (1964) is shown to be internally inconsistent when variations in magnetic-field strength along the current sheet are included. The inconsistency can be removed for both incompressible and compressible flow provided the magnetic-field lines in the narrow region between a pair of shock waves are pulled out into long loops rather than being only slightly bowed. If the mechanism is modified in this way, the rate of energy conversion is not significantly altered. However, there are several difficulties that remain and, unless they can be overcome, Petschek's mechanism must be considered unworkable. (auth)

3491 UPPER LIMITS ON THE LUNAR ATMOSPHERE DETERMINED FROM SOLAR-WIND MEASUREMENTS. Siscoe, G. L.; Nukherjee, N. R. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). J. Geophys. Res.; 77: No. 31, 6042-51(1 Nov 1972).

Ionization of the lunar atmosphere by solar photons and solar-wind particles will create perturbations in the solar wind. Observations by lunar-orbiting Explorer 35 show that any such perturbations are generally <10% in the magnetic field (the practical threshold of detectability) but that they may occasionally be >10%. The perturbations occasionally observed may be due to transient increases in the atmosphere or to some other cause. Upper limits on the steady-state atmosphere, which correspond to a perturbation of 10%, can be determined if the coupling between the ionized atmosphere and the solar wind is known. Upper limits are given here for two coupling limits: a single-fluid limit, in which the ions instantly join the solar-wind flow, and a two-fluid limit, in which the ions are coupled to the wind by the steady solar-wind electric and magnetic fields. The results give upper limits on the surface density of between 10^9 and 10^5 cm^{-3} for H, H_2, He, Ne, Ar, O, O_2, N, N_2, H_2O, OH, NO, N_2O, CO, CO_2, and CH_4. (37 references) (auth)

3492 TIME VARIATIONS OF MAGNETOSPHERIC INTENSITIES OF OUTER ZONE PROTONS, ALPHA PARTICLES, AND IONS (Z > 2). Randall, Bruce Aubrey. Iowa City, Iowa; Univ. of Iowa (1972). 94p. University Microfilms Order No. 72-26,726.

Thesis.

A comprehensive study of the temporal behavior of trapped protons, alpha particles, and ions (Z > 2) in the outer zone of the Earth's magnetosphere were made. These observations were made by the Injun-V satellite during the first 21 months of operation, August 1968 to May 1970. Rapid increases in the observed number of particles followed by slower exponential decay characterize the data. Comparisons are made with the temporal behavior of interplanetary particles of the same energy observed by Explorer 35. Increases in the trapped fluxes generally correspond to enhanced interplanetary activity. The energy spectra of protons and alpha particles at L = 3 have similar shapes when compared on an energy per charge basis while the respective polar-cap spectra have similar shape on an energy per nucleon basis. Apparent inward trans-L motion of energetic protons is observed. The temporal association of interplanetary particles, the apparent trans-L motion, and the charge dependence of the energy spectra lead one to believe that the source of increases of trapped particles is energetic solar particles penetrating to the polar cap. These particles are diffused inward by a process involving fluctuating electric fields. The loss of trapped low-altitude protons, alpha particles, and ions (Z > 2) is controlled by coulombic energy loss in the atmosphere. (Diss. Abstr. Int., B)

3493 SOME PROBLEMS IN SOLAR TERRESTRIAL PHYSICS. Gregory, Christopher Thomas. San Diego, Calif.; Univ. of California (1972). 180p. University Microfilms Order No. 72-24,631.

Thesis.

The problem of a Prandtl–Meyer expansion of a gas allowing for the presence of electromagnetic fields and nonconducting walls is examined. In the absence of electric fields it is found that solutions to the equations of motion may be discovered up to quadratures. In the more general case, numerical techniques are used to solve the equations. Various problems in solar–terrestrial physics are discussed. The loss of energetic protons and helium ions from the magnetosphere resulting from charge-exchange collisions with neutral geocoronal hydrogen atoms and pitch-angle scattering of ions into the atmospheric loss cone are considered. Pitch-angle distribution functions for protons and helium ions are found. The flux of positrons, 0.51-MeV annihilation γ rays, and energetic neutrons at Earth are computed under the assumption that these are produced by nuclear interactions in the solar atmosphere. The results are compared with observations. Charge-exchange collisions between interplanetary neutral H atoms and solar-wind He^{++} solar-wind protons as leading to fluxes of neutral H atoms and He^+ ions in the solar wind are considered. Photoionization is also considered as contributing to the He^+ flux. A simple model is used to compute the intensity of resonantly backscattered solar He II (λ 304 Å) and Lyman-α radiation. A simple two-stage propagation model is proposed for solar particles to compute the time dependence of the proton–α particle and α-particle–medium nuclei flux ratios at the Earth as well as the time dependence of the fluxes of protons, α particles, and medium nuclei. (Diss. Abstr. Int., B)

3494 STRUCTURE OF THE EARTH'S BOW SHOCK. Biskamp, D.; Welter, H. (Max-Plank-Institut fuer Plasma-Physik, Munich). J. Geophys. Res.; 77: No. 31, 6052-9(1 Nov 1972).

Numerical simulations have provided detailed information of the microscopic processes that occur in a high Mach number oblique shock wave such as the bow shock. The gross feature of the ion dissipation is a strong interaction of the reflected ions with the whistler precursor, which can be explained by a nonlinear ion–ion counterstreaming instability. The instability simultaneously amplifies the magnetic oscillations of the whistler, which supports the strong magnetic turbulence at the bow shock. In addition, electrostatic substructures have been observed that significantly enhance the thermalization of the ion distribution on the Debye scale. (auth)

3495 VLF–ELF RADIATION CHARACTERISTICS OF A 90°-PHASED CROSSED-DIPOLE ARRAY IN A COLD MULTICOMPONENT MAGNETOPLASMA. Wang, T. N. C. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res.; 77: No. 31, 6168-80(1 Nov 1972).

Linear electromagnetic theory is used to find the vlf-elf radiation characteristics of a quadrature-phased crossed-dipole array in a cold multicomponent magnetoplasma. Each dipole is perpendicular to the static magnetic field B_0, and the current on each is assumed to have a skin-triangular distribution. Formal solutions valid throughout the vlf and elf ranges are derived for the total radiated complex power and mutual coupling power. These solutions are used to obtain both numerical results and approximate closed-form expressions for mutual input impedance ΔZ applicable to the driving terminals of either dipole of the array. Approximate closed-form expressions for the power fluxes parallel and perpendicular to B_0 are also derived. When a right-circularly phased dipole array is used as a radiating source in the vlf range, the total power radiated into the whistler mode is increased, and the power flux along the field line is enhanced by a factor of 4 compared to that from a single dipole carrying the same current. In the elf range, the effects are similar but more complicated. The mutual input reactance due to the effects of medium anisotropy and circular phasing of the dipole array are found to be negligible. It is shown that the power flux along B_0 from a right-circularly phased dipole array peaks by at least 1 order of magnitude at approximately half the electron gyrofrequency. This result suggests a possible use of the proposed array as a radiating source to trigger artificially stimulated vlf emissions. (auth)

3496 REINTERPRETATION OF THE PIONEER 6 BOW SHOCK CROSSING. Mariani, F. (Univ., Rome); Ness, N. F.; Chao, J. K. J. Geophys. Res.; 77: No. 31, 6060-70(1 Nov 1972).

The interesting bow-shock crossing of Pioneer 6 on December 16, 1965 is re-examined and reinterpreted by combining the high-resolution data for the magnetic field measurements and all the available plasma data. It is shown that, although a small correction of the magnetic-field data improves the validity test of the MHD Rankine–Hugoniot (R–H) conditions, it is the plasma density measurements that are the principal source of the remaining inconsistencies. With the exception of the densities, the best agreement between the measurements and the R–H relations is obtained when the specific heat ratio γ is slightly less than the classical value of $5/3$ expected for a magnetized plasma in the magnetosheath. A more accurate shock normal determination has been made, and it is found that the shock itself is possibly in motion with respect to the Earth and that locally it may be approximated as a normal shock. (auth)

3497 MAGNETOPAUSE MOTIONS AT LUNAR DISTANCE DETERMINED FROM THE EXPLORER 35 PLASMA EXPERIMENT. Howe, H. C. (Massachusetts Inst. of Tech., Cambridge); Siscoe, G. L. J. Geophys. Res.; 77: No. 31, 6071-86(1 Nov 1972).

From solar-wind plasma observations on the lunar orbiting Explorer-35 satellite, multiple boundary crossings were analyzed to give statistical information on the tail boundary motions at lunar distance. In eleven months of observations, more than twice as many crossings occurred on the dawn side as on the dusk side, indicating a dawn–dusk asymmetry. The amplitude of boundary motion, given by the standard deviation of the observed positions around the average value, is 4.9 R_E on the dawn side and 2.8 R_E on the dusk side. Histograms of the time intervals between boundary crossings indicate two time scales are simultaneously present (16.7 min and 63.3 min, dawn-side values). A fit of the number of crossings and the histogram data to models of the motion indicates that the amplitude of the long-period motion is 2 to 3 times larger than that of the short-period motion. The inferred speeds for both motions lie in the range 10 to 20 km/sec. The models estimate the thickness of the plasma boundary layer to be 2 R_E. (auth)

3498 EFFECTS OF THE SECULAR MAGNETIC VARIATION ON THE DISTRUBUTION FUNCTION OF INNER-ZONE PROTONS. Farley, T. A.; Kivelson, M. G. (Univ. of California, Los Angeles). J. Geophys. Res.; 77: No. 31, 6087-92(1 Nov 1972).

The equation governing the distribution function of high-energy protons in the Earth's radiation belt has been modified to include the effects of the secular change of the Earth's magnetic dipole moment in addition to the effects of albedo neutron decay, collisional energy loss, and radial diffusion, which have been studied in the past. Because the time scale of the magnetic-field change (~2000 years) is much longer than the time scale of proton trapping (~200 years) an approximate solution of the equation can be obtained. This solution indicates that the shrinking dipole increases the distribution function at the geomagnetic equator for $1.15 < L < 1.7$ and $15 < E < 160$ MeV. The greatest increase occurs at $L = 1.2$, where it is as large as a factor of 5. The addition of this effect improves the agreement between the theoretically computed distribution function and the experimental data. (auth)

3499 EQUATORIAL CURRENT SHEET IN THE MAGNETOSPHERE. Sugiura, Masahisa (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 31, 6093-6103(1 Nov 1972).

The ΔB distribution deduced from the Ogo 3 and 5 satellites shows large field depressions in the equatorial region inside the plasmasphere. The existence of this $-\Delta B$ region is established by demonstrating that contours of differential ΔB, derived by ΔB (Kp = 2 – 3) – ΔB (Kp = 0 – 1), have characteristics similar to those of ΔB contours, and thus the possibility is eliminated that the ΔB distribution in question may have arisen from errors in the reference fields used to calculate ΔB or systematic errors in the orbit determination. On the basis of the ΔB distribution it is shown that what is usually considered the quiet-time ring current is an equatorial sheet current that is an extension of the neutral sheet current in the magnetospheric tail. The primary source of the large field reductions inside the plasmasphere is a population of protons with energies of 0.1 to 1 MeV initially detected by Davis and Williamson (1963) and Davis (1965) on Explorer 12, 14, and 15. Low-energy protons extensively measured on Ogo 3 by Frank (1967, 1971) are primarily responsible for the current near and outside the plasmapause. Although the sources of the current are identified with the workers who discovered protons in these two different energy ranges, the division of the sheet current into two separate current belts is arbitrary and inadvisable unless future experiments indicate the necessity for such a division. The presently available magnetic-field data are concordant with a sheet current continuous from the tail to 2.5 R_E. It is suggested that from the standpoint of particle dynamics in the magnetosphere an equatorial charged-particle sheet including all energies may be a more useful concept than the conventional concepts of the plasma sheet and the plasmasphere. (25 references) (auth)

3500 SATELLITE OBSERVATIONS OF ENERGETIC HEAVY IONS DURING A GEOMAGNETIC STORM. Shelley, E. G.; Johnson, R. G.; Sharp, R. D. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). J. Geophys. Res.; 77: No. 31, 6104-10(1 Nov 1972).

Large fluxes of energetic heavy ions ($M/q \approx 16$) were observed in the inner magnetosphere during the geomagnetic storm of December 17, 1971. The observations were made by a set of energetic-ion mass spectrometers covering the energy range 0.7 to 12 keV on board the polar-orbiting satellite 1971-089A (800-km altitude, ≈0300 LT). Significant heavy-ion fluxes were observed for a period of approximately 48 hours during the main phase of the storm. The heavy-ion fluxes frequently exceeded the proton fluxes in the 0.7- to 12-keV energy range. The heavy-ion spectrums were highly variable and frequently contained a peak of several keV. The heavy ions were observed over a wide latitudinal range ($2.4 \lesssim L \lesssim 9$) and generally extended to somewhat lower latitudes than the protons. The peak energy flux of these ions was approximately 0.4 erg/cm^2 sec ster, which is substantial in terms of expected observable ionospheric effects. They may also contribute significantly to the storm-time magnetic-field depression (Dst), since at the same flux they represent an energy density greater by a factor of 4 than that of the protons. (auth)

3501 REMARKS ON THE HEATING OF SOLAR-WIND PROTONS. Chao, J. K. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res.; 77: No. 31, 6226-9(1 Nov 1972).

The heating of solar-wind protons cannot be explained by the thermalization of those protons arising from the ionization of neutral hydrogen atoms traveling in the general direction of the Sun. By requiring the heating to satisfy the experimental results of T_p versus V_{sw} correlation, the efficiency function $\eta(V_{sw})$ of thermalization of these incoming protons and a value of the "hot component" of hydrogen population $n_1 \approx 0.05$ cm^{-3} near 1 AU are obtained. This hot-component hydrogen density is too high compared to recent estimates by satellite experiments of Lyman-α

radiation and other experiments, and therefore the suggested solar-wind heating mechanism is unimportant in explaining the T_p versus V_{sw} correlation. (29 references) (auth)

3502 PLASMA SHEET CONTRIBUTION TO THE FORCE BALANCE REQUIREMENTS IN THE GEOMAGNETIC TAIL. Siscoe, G. L. (McDonnell Douglas Astronautics Co., Huntington Beach, Calif.). J. Geophys. Res.; 77: No. 31, 6230-4(1 Nov 1972).

The plasma sheet is shown to be necessary to account for the dual quiet-time conditions of no net force on the mass in the tail and no energy transport from the solar wind to the tail. In the absence of a plasma sheet the requirement of force balance implies the necessity of a tangential drag on the tail. The associated energy transport is sufficient to supply a magnetic storm; thus the quiet-time assumption is violated. The presence of the plasma sheet removes this difficulty. The resulting force equilibrium is shown to be stable in that fluctuations in the plasma sheet thickness produce forces to restore the equilibrium situation. The onset of tangential stress, such as characterizes the initial phase of a substorm, induces tailward motions in the plasma sheet, causing it to thin and cool by expansion. The removal of tangential stress induces earthward motions in the plasma sheet, causing it to thicken and heat by compression. (auth)

3503 COMPARISON OF MAGNETOSPHERE MODELS WITH STORM OBSERVATIONS FROM EXPLORER 26. Parady, Bodo; Cahill, L. J. Jr. (Univ. of Minnesota, Minneapolis). J. Geophys. Res.; 77: No. 31, 6235-42(1 Nov 1972).

Distortions of the inner magnetosphere observed during the storm of April 17, 1965, are compared with distortions produced by various models. Although a symmetrical ring-current model agrees well with observation during the slow recovery phase of the storm, neither the ring-current model nor the Williams–Mead tail can be adjusted to agree with the observed distortions in the development phase. Part of the discrepancy results from comparing static models with rapidly changing distortions in the real magnetosphere. During the initial phase, and even in quiet times, a compression model (untilted) cannot account for all the distortion observed in the inner magnetosphere. (auth)

3504 INSTABILITY OF RING-CURRENT PROTONS BEYOND IN THE PLASMAPAUSE DURING INJECTION EVENTS. Coronti, F. V. (Univ. of California, Los Angeles); Fredricks, R. W.; White, Roscoe. J. Geophys. Res.; 77: No. 31, 6243-8 (1 Nov 1972).

The stability of ring-current protons with an injection spectrum modeled by a loss cone distribution function is examined for typical ring-current parameters. It is found that a quasi-electrostatic ion loss cone mode can be excited with frequencies just below and growth rates of the order of 10^{-3} times the ion plasma frequency. The instability is strongest in the moderate $\beta \sim 1$, low-density region just outside the plasmapause; for the $\beta \gg 1$ auroral regions and the high-density plasmasphere the mode is nearly stable. For the same ring-current parameters the electromagnetic ion-cyclotron wave is almost nonconvectively unstable, with growth rates of the order of 10^{-1} times the ion-cyclotron frequency. The combination of the two unstable modes results in a large quasi-linear diffusion coefficient throughout most of the proton velocity space. Unless it is maintained by rapid inward convection, the ring-current injection anisotropy will be reduced by diffusion toward the loss cone on time scales short in comparison to the minimum precipitation lifetime. (auth)

3505 NONUNIQUENESS OF MAGNETIC FIELD LINE MOTION. Vasyliunas, V. M. (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res.; 77: No. 31, 6271-4(1 Nov 1972).

Birmingham and Jones (J. Geophys. Res., 73: 5505(1968)) state that the presence of a conducting surface through which all field lines pass permits a unique, legitimate, and significant identification of the motion of magnetic-field lines. Lezniak and Winckler (J. Geophys. Res., 75: 7075(1970)) deduced from energetic electron and magnetic-field observations that, during substorms in the premidnight LT region, the outer magnetosphere is inflated and, therefore, field lines move outward; they find this result inconsistent with the observations of Vasyliunas (J. Geophys. Res., 73: 2839(1968)) that during substorms the plasma sheet moves earthward, the field lines presumably moving with it. Rostoker (Rev. Geophys. Space Phys., 10: 157(1972)) finds the results from these two observations inconsistent. The author now shows that there is no unique definition of field-line motion, with or without perfectly conducting surfaces. An infinite set of velocity fields exists, each of which can properly be said to describe the motion of magnetic-field lines; this set includes, but is not limited to, all possible bounce-averaged motions of charged particles. The use of different definitions of field-line motion in the same physical situation is illustrated. (J.C.W.)

3506 COMMENTS ON THE GROWTH PHASE OF MAGNETOSPHERIC SUBSTORMS. Akasofu, S. I.; Snyder, A. L. (Univ. of Alaska, Fairbanks). J. Geophys. Res.; 77: No. 31, 6275-7(1 Nov 1972).

In order to accurately study the growth phase of magnetospheric substorms from satellite observations, it is important to synchronize the observational data. Several proposed features of growth phases are (1) a slow growth of a negative bay prior to a rapid growth; (2) the thinning of a plasma sheet; (3) a change in the configuration of the geomagnetic field from dipolar to tail-like at a distance of synchronous satellites; (4) the growth of a current system in the polar cap; (5) the growth of a westward electric field; and (6) the equatorward motion of auroras. It is shown that magnetic records from the present network of auroral-zone stations are not necessarily sufficient to determine the onset time of the expansive phase (i.e., T = 0), the most obvious reason being that all stations are not directly underneath the arc. An effort should be made to identify field and plasma variations that occur at the onset of the expansive phase on the basis of all-sky photographs rather than auroral-zone magnetic records. (J.C.W.)

3507 MAGNETIC FIELD ON THE EQUATORIAL ELECTROJET. Park, David (Williams Coll., Williamstown, Mass.). J. Geophys. Res.; 77: No. 31, 6278-9(1 Nov 1972).

Kannangara (J. Geophys. Res., 77: 6161(1972)) discusses the horizontal and vertical components of fluctuations in the magnetic field near the geomagnetic equator and interprets the results in terms of a model that attributes them to fluctuating currents in the ionosphere. His work on calculating the ratio of the vertical component of the field fluctuations to the horizontal component is discussed. It is shown that to calculate the ratio of the magnitudes of the fields in the case considered (d/h = 0.75), Kannangara's formula represents an interpolation between formulas valid for large and small skin depth. For the case considered, d is the distance from the line underneath the primary current. Kannangara assumed that the primary current I can be approximated by a line or flat ribbon at a height, h, fluctuating with frequency, ω. Since the result for the flat ribbon is a trivial extension of that for the line, the author only discusses that for the line. The only approximation made is that the free-space wavelength corresponding to the fluctuating frequencies is long in comparison with the skin depth and the height of the primary current above ground. (J.C.W.)

3508 ORIGIN OF SMALL-SCALE TYPE-II IRREGULARITIES IN THE EQUATORIAL ELECTROJET. Rogister, Andre; D'Angelo, Nicola (European Space Research Organization, Frascati, Italy). J. Geophys. Res.; 77: No. 31, 6298-9(1 Nov 1972).

The order of magnitude of the largest wave number at which suprathermal fluctuation levels can be nonlinearly excited by the cross-field instability in the equatorial electrojet is estimated. Previous conclusions were stated that the cross-field instability, which was suggested as a plausible source of type-II irregularities, was based on a linear theory of the instability. Nonlinear processes are available that reconcile theory and experiment. Actually, estimates are made of the size of the shortest wavelengths, which, although they are linearly stable, can be nonlinearly excited to a suprathermal fluctuation level. Certain conditions are discussed for observations in the equatorial electrojet and under these conditions the waves are nondispersive, and they are locked in phase and interact resonantly; hence, mode–mode coupling effects must be very important. (J.C.W.)

3509 NORTH/SOUTH ASYMMETRIC ENTRY OF SOLAR PROTONS DURING THE NOVEMBER 18, 1968 EVENT. Aarsnes, K.; Amundsen, R. (Univ., Bergen). Planet. Space Sci.; 20: No. 11, 1835-41(Nov 1972).

Solar proton observations by the ESRO-IA satellite are presented for the November 18, 1968 event. The time history of proton influx over the polar regions, showing a clear north/south asymmetry during the onset phase of the event, is presented. (auth)

3510 DUCTED PROPAGATION OF PP MICROPULSATIONS IN THE MAGNETOSPHERE AND PP DOTTING. Witchalls, M. W. (Univ. of Auckland, N. Z.). Planet. Space Sci.; 20: No. 11, 1817-33(Nov 1972).

Dynamic spectrograms (frequency-time displays) of PP (pearl-type Pc 1) micropulsations commonly possess two notable features: (1) they consist of a sequence of rising tones, (2) the individual rising tones have a dotted structure. Property (1) is attributed to propagation of the micropulsations back and forth along field-aligned paths in the magnetosphere. Previous theoretical inves-

tigation has shown that, despite the "natural" guidance properties of PP waves, such hemisphere-to-hemisphere propagation along field lines would not succeed in the absence of some form of "artificial" guidance, such as trapping in field-aligned columns of enhanced ionization. A simple waveguide theory is developed that describes the propagation of PP waves along such field-aligned ducts. Property (2), the dotting of PP spectra, is then explained as being due to simultaneous propagation of PP waves along a group of field-aligned ducts. (auth)

3511 PROPAGATION OF Pc1 MICROPULSATIONS IN A PROTON–HELIUM MAGNETOSPHERE. Fraser, B. J. (Univ. of Colorado, Boulder). Planet. Space Sci.; 20: No. 11, 1883-93 (Nov 1972).

The dispersive propagation of Pc-1 hydromagnetic emissions in a proton-helium magnetosphere is considered. The addition of singly charged helium ions to the medium allows the propagation of hydromagnetic nose emissions. A graphical method that determines the nose emission propagation path, and the proton and helium concentrations at the top of the path, is presented. Only three of twelve nose emissions considered are consistent with the proton-helium explanation. The propagation of two or more adjacent narrow-band emissions along different tubes of force in a proton magnetosphere is considered as an alternative explanation. It is also shown that propagation path L values of normally dispersed hydromagnetic emissions may be increased by 0.1 to 0.5 Earth radii by helium concentrations of 3 to 10%. (auth)

3512 MODEL DEVELOPMENT OF SUPERSONIC TROUGH WIND WITH SHOCKS. Grebowsky, J. M. (Goddard Space Flight Center, Greenbelt, Md.). Planet. Space Sci.; 20: No. 11, 1923-34(Nov 1972).

Time-dependent one-dimensional hydrodynamic equations describe the evolution of the thermal plasma flow along closed magnetic-field lines outside of the plasmasphere. The convection of the supersonic polar wind onto a closed field line results in the assumed formation of collisionless plasma shocks. These shocks move earthward as the field line with its "frozen-in" plasma remains fixed or contracts with time to smaller L coordinates. The high equatorial plasma temperature (of the order of electron volts) produced by the shock process decreases with time if the flow is isothermal but it will increase if the contraction is under adiabatic conditions. Assuming adiabaticity, a peak in the temperature forms at the equator in conjunction with a depression in the ion density. After an initial contraction, if the flux tube drifts to higher L coordinates, the direction of the shock motion can be reversed so that the supersonic region will expand along the field line towards the state characterizing the supersonic polar wind. A rapid expansion will lower the equatorial density while the temperature decreases with time under adiabatic but not isothermal conditions. (auth)

PHYSICS (ATOMIC AND MOLECULAR)

Beams and Their Reactions

3513 (ANL-7960(Pt.1), pp 14-42) REPORT ON THE ENERGY AND ANGULAR DISTRIBUTIONS OF SECONDARY ELECTRONS. Kim, Yong-Ki. June 1972.

In Radiological and Environmental Research Division annual report, July 1971-June 1972.

Theoretical checks which serve to assess the reliability of recent experimental data on the angular and energy distributions of secondary electrons ejected by fast electrons and protons are discussed, along with the relevance of such data to various fields of radiation research. Appropriate forms of the Rutherford, the Mott, the binary-encounter, and the Born formulas and their limitations are given. The experimental data on the energy distribution of electrons ejected from He by fast electrons ($\geq$ 500 eV) agree with the Born cross sections within ~ 30% near the ionization threshold. Recommendations, which would serve as the benchmarks for the experimental data on secondary electrons, are also presented. (29 references) (auth)

3514 (ANL-7960(Pt.1), pp 49-64) OSCILLATOR STRENGTH VALUES DERIVED FROM ELECTRON ENERGY LOSS SPECTRA OF MOLECULES. Huebner, R. H.; Celotta, R. J. June 1972.

In Radiological and Environmental Research Division annual report, July 1971-June 1972.

A method for obtaining apparent oscillator strengths from electron energy-loss spectra is presented and discussed. Application of this technique to energy loss data on acetone, methanol, and ethanol obtained for 100-eV incident electrons yields values in reasonably good agreement with optical data. However, the accuracy of this method is limited by lack of knowledge concerning the generalized oscillator strength function, $f_n(K)$. (auth)

3515 (FRNC-TH-248) STUDY OF THE PRODUCTION OF DOUBLY CHARGED IONS WITH A CALUTRON TYPE SOURCE. Urquidi Fernandez, Mirna (Paris Univ., Orsay (France)). 1972. 53p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The different ways in which the rate of production of doubly positive-charged ions can be increased using a calutron source are discussed. The yield of doubly charged ions was defined from the ratio of the singly and doubly charged ions extracted. The discharge parameters were varied. The I^{++}/I^{+} ratio varies with I(cat) in the pressure limited region. This ratio varies in a sensibly linear way with V(arc) and B(magnetic field) independent of the operating region. The ratio decreases when the flow is increased. An attempt is made to explain the experimental results using a theoretical model for the discharge. The introduction of a reflector in the source improves the I^{++}/I^{+} ratio. (France)

3516 VELOCITY DISTRIBUTION OF ATOMS ISSUING FROM A MULTI-CHANNEL GLASS CAPILLARY ARRAY AND ITS IMPLICATION ON THE MEASUREMENT OF ATOMIC BEAM SCATTERING CROSS SECTIONS. Angel, G. C.; Giles, R. A. (Queen's Univ., Belfast). J. Phys., B (London); 5: No. 1, 80-8(Jan 1972).

The velocity distribution of cesium atoms issuing from a multichannel glass capillary array was studied and an energy-exchange process proposed to account for the modification to a Maxwellian distribution. The importance of knowing the exact distribution in the measurement of atomic-beam total scattering cross sections is indicated by the calculation of the appropriate kinetic averaging factors. (auth)

3517 BEAM FOIL AUGER SPECTROSCOPY. Lucas, M. W.; Harrison, K. G. (Univ. of Sussex, Brighton, Eng.). J. Phys., B (London); 5: No. 2, L20-2(Feb 1972).

Secondary-electron velocity distributions were obtained from the back surfaces of thin carbon foils during light-ion bombardment. Small peaks in the spectra can be assigned to autoionization of transmitted ions or atoms in the beam; the energies of the electrons with respect to the beam being quite low (0.15 to 15 eV). A simple method of measuring the beam velocity after the foil is described and the possibilities of the beam-foil technique for studying autoionization are evaluated. (auth)

3518 INDIRECTLY HEATED CATHODE USED IN PARTICULAR FOR A HIGH POWER ION SOURCE. Frey, Jean-Jacques; Roche, Michel (to Commissariat a l'Energie Atomique). French Patent 2,105,407. 28 Apr 1972. Filed 4 Sep 1970. (In French).

An indirectly heated cathode intended (in particular) to be used in a high-power ion source is presented. This cathode possesses a heating element that surrounds the electron emitter or active element. (France)

3519 DEVICE FOR PRODUCING INTENSE ION BEAMS (ESPECIALLY METALLIC IONS). Gautherin, Guy; Masic, Rene; Warnecke, Robert; Kervizic, Francois (to Societe Thomson-CSF). French Patent 2,102,546. 7 Apr 1972. Filed 7 Aug 1970. (In French).

An improvement to a device (previously described) for producing intense ion beams is presented. In this device, the primary plasma is produced from an inert gas whose molecules have small ionization cross sections and large recombination cross sections (e.g., He, N, or Ar). (France)

3520 ELECTRON EMISSION BY A (100) FACE OF A TUNGSTEN SINGLE CRYSTAL SUBJECTED TO A BEAM OF SLOW ELECTRONS. Yakubova, Z.; Gorbatyi, N. A. (Tashkent State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 129-30 (1972). (In Russian).

The energy dependence of the coefficient of elastic reflection of slow electrons, the coefficient of the true secondary and inelastically reflected electrons, and the coefficient of secondary emission were investigated under conditions of controlled purity and ultra-high vacuum with a homogeneous face (100) of a W single crystal. The path of the experimental curve of the energy dependence of the coefficient of reflection on the (100) face confirms the two maxima predicted by theory. (K.S.W.)

3521 NEGATIVE ION SOURCE PRODUCING A HIGH INTENSITY RECTILINEAR BEAM. Baribaud, M.; Dolique, J.-M.; Zadworny, F. (to Agence Nationale de Valorisation de la Recherche). French Patent 2,106,642. 5 May 1972. Filed 18 Sep 1970. (In French).

A negative ion source producing a high-intensity rectilinear beam is described, particular emphasis being given to an H^- beam. (France)

3522 CHEMICAL EFFECTS ON ION-EXCITED ALUMINUM K X-RAY SPECTRA. Burkhalter, P. G.; Knudson, A. R.; Nagel, D. J.; Dunning, K. L. (Naval Research Lab., Washington, D. C.). Phys. Rev., A.; 6: No. 6, 2093-2101(Dec 1972).

Five-MeV He and Ne ions were used to excite the aluminum Kα and Kβ parent and satellite x-ray spectra of Al metal, oxide, and nitride. Compared to the metal, the Kα line and Kα satellites from the oxide were at energies a few tenths of an eV higher with helium-ion excitation, similar to observations with electron excitation. With neon bombardment, the Kα satellite lines were broader and the energy shifts reduced because of target-atom recoil effects. The chemical shifts in the Kβ spectra vary from negative in the parent band with helium ions to positive shifts as large as 6 eV in the higher-energy Kβ satellites produced by neon ions; they were found to depend on the degree of L-shell ionization. (auth)

Atomic and Molecular Properties

Refer also to abstracts 3592, 3595, 3874, and 3875.

3523 LENGTH AND VELOCITY MATRIX ELEMENTS IN QUADRUPOLE TRANSITION CALCULATIONS. Cohen, M.; McEachran, R. P.; Rosenthal, D. (Hebrew Univ., Jerusalem). J. Phys., B (London); 5: No. 2, 184-92(Feb 1972).

Electric quadrupole multiplet strengths were calculated for a large number of transitions in He and Li^+ using analytical orbital wave functions of frozen-core type. Very good agreement between length and velocity forms of the transition matrix element is obtained when the orbitals have the correct asymptotic form. The velocity form is far less sensitive to small changes in the orbitals than is the length form. The bound-state contributions to the quadrupole polarizabilities of the ions He through B^{+3} were estimated from $^1S-{}^1D$ multiplet strengths, and it is concluded that the continuum contributions are very large. (auth)

3524 CALCULATION OF THE INTERACTION POTENTIAL AND HYPERFINE SHIFT IN HeH. Davison, W. D.; Liew, Y. C. (Queen's Univ., Belfast). J. Phys., B (London); 5: No. 2, 309-20 (Feb 1972).

The interatomic potential V(R) and hyperfine splitting constant a(R) for a hydrogen atom in interaction with a helium atom are calculated as functions of the internuclear distance R ($3 \leq R \leq 12a_0$) by a generalized valence-bond procedure, using up to 19 carefully chosen configurations constructed from Slater orbitals

with R dependent exponents. Using these configurations, a separate perturbation calculation of the coefficients of the leading (R^{-6}) terms in the asymptotic expansions of V(R) and a(R) yields values in good agreement with previous estimates. Comparison with previous calculations of V(R) indicates that further investigation is required to establish accurate values in the vicinity of the potential minimum. The function a(R) is also found to exhibit a shallow minimum, and it is emphasized that calculations of a(R) can be inaccurate if the decision on which terms to include in the wave function is based on energetic considerations alone. The computed hyperfine shift at 50°C is 10% smaller than the most recent experimental value, the agreement becoming closer with increasing temperature. Values obtained for the temperature derivative of the shift are consistent with the available experimental data. (auth)

3525 $\alpha^2 \ln\alpha^-$ RECOIL CORRECTIONS TO THE HYDROGEN HYPERFINE STRUCTURE AND THE PROTON POLARIZABILITY. Cole, Robert S.; Repko, Wayne W. (Michigan State Univ., East Lansing). Phys. Rev. Lett.; 29: No. 19, 1295-7(6 Nov 1972).

A calculation of the order $(m_e/m_p)\alpha^2 \ln\alpha^{-1}$ corrections to the hyperfine splitting (ν_H) of the hydrogen ground state is reported. The result, $\Delta\nu_H = \frac{8}{3}(m_e/m_p)^2(1 + m_e/m_p)^{-5}c\alpha^4 R_\infty \ln\alpha^{-1}[9 + 7\kappa(1 + \kappa) - (m_e/m_p)\kappa(3 + 14\kappa)] = 0.0016$ MHz (1.1 ppM), is used in conjunction with the corresponding formula for the muonium hyperfine interval to obtain an estimate of the proton polarizability. (auth)

3526 HELIUM QUENCH RADIATION AND TRANSITION POLARIZABILITY. Drake, G. W. F. (Univ. of Windsor, Ont.). Can. J. Phys.; 50: No. 17, 1896-1902(1 Sep 1972).

An accurate calculation of the quenching rate for metastable singlet helium atoms and helium-like ions in a constant electric field is presented. The theoretical rate for helium is $(0.932 \pm 0.001)F^2\ s^{-1}$, where F is the field strength in kV/cm, in agreement with the recent experimental value $(0.926 \pm 0.02)F^2\ s^{-1}$. In addition, several oscillator strength sums are evaluated, along with the static and transition dipole polarizabilities of the $1\ ^1S$, $2\ ^1S$, and $2\ ^3S$ states for the helium-like ions up to Ne IX. (auth)

3527 ERROR BOUNDS TO LONG-RANGE THREE-BODY AND RELATIVISTIC INTERACTIONS BETWEEN ATOMS. Starkschall, G.; Gordon, R. G. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys.; 57: No. 8, 3213-20(15 Oct 1972).

Dipole oscillator strength distributions, constructed to reproduce known information about atomic polarizabilities, oscillator strengths, and photoionization cross sections, are used to calculate rigorous upper and lower bounds to long-range three-body and relativistic interactions between atoms. (auth)

3528 REANALYSIS OF THE HYPERFINE STRUCTURE OF THE $4f^66s^2\ ^7F$ MULTIPLET IN ^{147,149}Sm, INCLUDING MEASUREMENTS FOR THE $^7F_6$ STATE. Childs, W. J.; Goodman, L. S. (Argonne National Lab., Ill.). Phys. Rev., A.; 6: No. 6, 2011-21(Dec 1972).

The hyperfine structure (hfs) of the J = 6 member of the $4f^66s^2\ ^7F$ ground multiplet of ^{147,149}Sm was measured by the atomic-beam magnetic-resonance technique, and that of the J = 1 to 5 states was remeasured. The magnetic-dipole and electric-quadrupole hyperfine-interaction constants obtained, after correction for second-order hfs, are found to be consistent to a very high order with the three-parameter formulation of the Sandars–Beck effective-operator theory of hfs and with the Conway–Wybourne eigenvectors for the J = 1 to 6 ^7F states of Sm. The earlier apparent failure of these eigenvectors to be consistent with the magnetic dipole hfs of the ^7F states with J = 1 to 5 is now resolved. (auth)

3529 ODD-PARITY D STATES IN He. Bhatia, A. K. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Rev., A.; 6: No. 6, 2498-2500(Dec 1972).

Positions of the lowest odd-parity ^{1,3}D states in He were calculated variationally. The trial wave function of Hylleraas type with four nonlinear parameters was used. The results for the lowest ^{1,3}D states obtained by using 112 terms in the wave function are lower than the previous results. The mass-polarization correction was also calculated. The transition $2^3P^e \rightarrow 3^3D^0$ is of wavelength 3014.16 Å, which agrees well with the previous calculation and the experimental result. The $^{1,3}D^0$ states of H^- were also investigated, but no states of odd parity were found in this calculation. (auth)

Positronium, Muonium, and Muonic and Mesic Atoms and Molecules

Refer also to abstracts 3582, 3767, and 3773.

3530 STRONG INTERACTION EFFECTS IN ANTIPROTONIC ATOMS. Backenstoss, G.; Bamberger, A.; Bunaciu, T.; (and others) (CERN, Geneva). Phys. Lett.; 41B: No. 4, 552-6(16 Oct 1972).

Yields of the last observable x-ray transitions in antiprotonic atoms were measured for groups of neighboring elements. In sulfur a natural line width and an energy shift could be observed. These data are compared with calculations describing the $\bar{p}$–nucleus interaction in terms of an optical potential using the free $\bar{p}$–N scattering lengths. (auth)

3531 VACUUM POLARIZATION IN EXOTIC ATOMS. Blomqvist, J. (Research Inst. for Physics, Stockholm). Nucl. Phys., B48: No. 1, 95-103(1972).

The e^+e^- vacuum polarization potential around a point charge Ze is given in explicit form to orders $\alpha Z\alpha$, $\alpha^2 Z\alpha$ and $\alpha(Z\alpha)^3$. The potentials are expanded in series of powers of r and log r. The energy of the 5g → 4f transition in muonic Pb is evaluated. The deviation from the observed energy is found to be smaller than in previous calculations. (auth)

3532 POSITRONFIT: A VERSATILE PROGRAM FOR ANALYSING POSITRON LIFETIME SPECTRA. Kirkegaard, Peter; Eldrup, Morten (Danish Atomic Energy Commission Research Establishment, Risoe). Comput. Phys. Commun.; 3: No. 3, 240-55(1972).

Positron lifetime spectra are analyzed by an iterative least-squares technique of semilinear type. The mathematical model is a sum of decaying exponentials convoluted with a gaussian resolution function, and with a constant background added. Fixed values can be imposed on any number of lifetimes and relative intensities. Correction for the source annihilation is taken into account. A statistical analysis is made, resulting in the covariance matrix of the estimated parameters. (A.G.W.)

3533 ENERGIES OF HIGHLY EXCITED HELIUM-LIKE EXOTIC ATOMS. Wright, D. E.; Russell, J. E. (Univ. of Cincinnati). Phys. Rev., A.; 6: No. 6, 2488-92(Dec 1972).

Extensive numerical results are presented concerning the energies of highly excited circular and nearly circular orbits of some helium-like exotic atoms. The atoms, together with the ranges of principal quantum numbers considered, are the $\alpha\pi^-e^-$ with $13 \le n \le 20$, the αK^-e^- with $23 \le n \le 36$, the $\alpha\bar{p}e^-$ with $31 \le n \le 47$, and the $\alpha\Sigma^-e^-$ with $34 \le n \le 52$. (auth)

Collision Phenomena

Refer also to abstracts 2384, 4294, and 4296.

3534 (ANL–7960(Pt.1), pp 2-12) TOTAL CROSS SECTION FOR INELASTIC SCATTERING OF FAST CHARGED PARTICLES BY THE NEON ATOM. Saxon, R. P. June 1972.

In Radiological and Environmental Research Division annual report, July 1971–June 1972.

Optical oscillator strength data and a calculation of the incoherent scattering function are used within the oscillator strength sum rule formulation to evaluate the total inelastic cross section for scattering of fast charged particles by neon. Sum rule values for S(–1), S(1), S(2) are checked by direct calculation. The total cross section is compared with experimental data of Rieke and Prepejchal (Phys. Rev.; A6: 1507(Oct. 1972)). (26 references) (auth)

3535 (FRNC-TH–254) ELECTRONIC EXCITATION TRANSFER IN NEUTRAL Cs VAPOR INDUCED BY COLLISIONS WITH ATOMS OR MOLECULES HAVING THERMAL ENERGIES. Pimbert, Michel (Paris Univ., Orsay (France). Faculte des Sciences). 1972. 130p. (In French). Dep. NTIS (U. S. Sales Only). Thesis.

The following excitation-transfer cross sections of Cs resulting from collisions with a Cs atom in the ground state or a rare gas atom (He, Ne, Ar, Kr or Xe) or simple molecule (H_2, N_2) were determined: the $8\ ^2P_{\frac{3}{2}}$ level to the $8\ ^2P_{\frac{1}{2}}$ level to the $4\ ^2F$ level. The quenching cross sections of the $8\ ^2P_{\frac{1}{2}}$ level in the presence of a rare gas or a molecular gas were also estimated. The measurements were effected at 420° (except those concerning the $8\ ^2P_{\frac{1}{2}} \rightarrow 8\ ^2P_{\frac{3}{2}}$ transition induced by collision with a rare gas atom, which were carried out at 420°K and 620°K in order to investigate the variation of these cross sections with the velocity of the particles). It was demonstrated that the magnitudes of the excitation-transfer cross sections are closely linked to the energy difference between the levels. The disagreement between the experimental results and the theoretically derived values demonstrates that collisions involving highly excited Cs atoms are different from those in which the Cs atom exists in the first excited states. (France)

3536 (ORNL-4826) ELECTRON SCATTERING FROM SIMPLE ATOMIC AND MOLECULAR SYSTEMS: A STUDY OF THE PHENOMENOLOGICAL AND MICROSCOPIC OPTICAL MODELS. Alton, G. D.; Garrett, W. R.; Turner, J. E. (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 136p. Dep. NTIS.

Thesis submitted by G. D. Alton to Univ. of Tennessee, Knoxville.

Optical-potential methods of analysis are used to study low-energy electron scattering from simple atoms and molecules. In order to specify the optical potential used to describe the collisional phenomena in question it is possible to take either a semi-empirical or a theoretical approach. Both of these approaches are used in this study. In the studies made with the phenomenological optical model, an attempt is made to obtain physically reasonable potential functions, which will reproduce certain experimentally observed electron–hydrogen, electron–helium scattering data. Local complex potentials, characterized by energy-dependent parameters, are used to generate elastic and inelastic scattering cross sections, which are compared with experimental measurements for the processes studied. The microscopic optical model offers a means of introducing more realistically the dynamical effects of all open and closed channels than many other analytical methods. The microscopic optical model is used in determining the total contributions to the elastic and inelastic scattering cross sections from all open channels for electron–atomic–hydrogen interactions. Mathematically tractable elastic channel equations are derived for electron scattering from hydrogen and diatomic molecules by approximating the intermediate-state coupling through a free-particle Green's function. The numerical procedure used to obtain the solution to these equations and to generate the elastic and inelastic scattering from hydrogen is discussed. The results are compared with available experimental measurements. (auth)

3537 MUTUAL NEUTRALIZATION WITH A COLLISION BETWEEN POSITIVE AND NEGATIVE IONS. Radtsig, A. A.; Smirnov, B. M. (Inst. of High-Temperature, Moscow). High Temp. (USSR) (Engl. Transl.); 10: No. 1, 24-8(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 29-34(1972).

A calculation is presented of the cross section of a charge exchange between a positive ion and a negative ion in the limiting case of small collision energies (≲1 eV), when the curvature of the trajectory of the interacting particles must be taken into account. The transition of a valence electron of a negative ion is regarded as a tunnel effect and passes through the whole group of levels of the atom. The probability of the transition of a valence electron of a negative ion with an arbitrary value of the orbital moment is found. The dependence of the rate constant of the mutual neutralization reaction is obtained for the limiting case of thermal energies. The calculated results are compared with experiment. (auth)

3538 ELECTRON TRANSMISSION STUDIES OF DECAY CHANNELS OF MOLECULAR RESONANCES. Larkin, I. W.; Hasted, J. B. (Univ. of London). J. Phys., B (London); 5: No. 1, 95-109(Jan 1972).

Measurements are reported of transmission of energy-monochromated electrons of energy 0.1 to 4 eV through oxygen, nitrous oxide, nitric oxide, nitrogen dioxide, carbon dioxide, and benzene. Energy-loss spectra are measured, and the zero-angle scattering functions for excitation of different vibrational levels are reported. The functions show oscillatory structure due to temporary negative-ion states. The function for O_2 is analyzed in terms of the compound state theory, yielding $O_2^-\,^2\Pi_g$ nuclear separation $r_e = 1.39$ Å in disagreement with the photodetachment value $r_e = 1.34 \pm 0.01$ Å (Celotta et al). The causes of this discrepancy are probably significant. The transmission functions for zero energy loss are treated by Fourier analysis, which yields the approximate vibrational energies of the temporary negative ion states of O_2^-, NO^-, NO_2^-, and $C_6H_6^-$. It is possible that a second state of NO_2^- contributes to the scattering at energies above 1.1 eV. (auth)

3539 FROZEN CORES APPROXIMATION FOR ATOMIC STRUCTURE CALCULATIONS. Seaton, M. J.; Wilson, P. M. H. (Univ. Coll., London). J. Phys., B (London); 5: No. 1, L1-3(Jan 1972).

The coupled integrodifferential equations for electron collisions with an N-electron ion may be solved at energies that give bound states for the (N + 1)-electron system. Results are obtained for the $^1P^0$ series in C^{2+}, including the configurations $1s^22snp$, $1s^22pn's$, $1s^22pn''d$ and $1s^22s2p$. The 1s, 2s, and 2p radial functions are calculated for C^{3+} and the np, n's, and n"d radial functions are solutions of the coupled integrodifferential equations. (auth)

3540 CUSP IN LOW ENERGY ELECTRON–SODIUM SCATTERING. Andrick, D.; Eyb, M.; Hofmann, M. (Univ. Trier-Kaiserlautern, Ger.). J. Phys., B (London); 5: No. 1, L15-17(Jan 1972).

A pronounced feature is observed in the differential cross section of elastic electron–sodium scattering. Shape and energetic position (2.1 eV) show that the structure is due to the opening of the inelastic 3^2P channel. (auth)

3541 GLAUBER CALCULATIONS OF POLARIZATION OF LYMAN-α RESULTING FROM e^-–H(1s) COLLISIONS. Gerjuoy, E. (Univ. of Pittsburgh); Thomas, B. K.; Sheorey, V. B. J. Phys., B (London); 5: No. 2, 321-33(Feb 1972).

The polarization fraction of the Lyman-α radiation emitted in e^-–H(1s) collisions was calculated using the Glauber, Born, and various Vainshtein approximations, and these predictions were compared with observation. It was found that the Born, Glauber, and all forms of the Vainshtein yield results that are very close to each other and to the data in the energy range $30\ \text{eV} < E_a < 700\ \text{eV}$. The comparatively small differences between the various approximations are detailed in the text; also, the reason for the close agreement of the predicted polarization fractions (although the computed 1s–2p total and differential cross sections are not so close) is explained. With respect to the Glauber approximation, the importance of computing the phase integral along a direction perpendicular to the momentum transfer q at each value of q is stressed. (auth)

3542 APPLICATION OF THE DISTORTION OPERATOR METHOD TO ELASTIC SCATTERING. Michalik, B. (Inst. of Plasma Physics, Prague). J. Phys., B (London); 5: No. 2, 346-54(Feb 1972).

The distortion method, derived previously, is briefly summarized for the case of partial waves. Further, it is applied with practical trial distortion functions to the s-wave electron–atomic-hydrogen scattering and to the scattering of particles by the exponential potential. A comparison with other methods is made. The present method, with a simple trial function, is found to be preferable both for its results and its simplicity. The variational principle for the so-called distortion matrix element is derived and the identity that is a counterpart to the ordinary Kato identity is applied to improve the results. The results are very good, especially for the exponential potential scattering, and require considerably less labor than the Kohn procedure. (auth)

3543 FREDHOLM AND PADE APPROXIMATIONS FOR COUPLED CHANNELS IN SCATTERING THEORY. Liew, Y. C.; Moiseiwitsch, B. L. (Queen's Univ., Belfast). J. Phys., B (London); 5: No. 2, 299-308(Feb 1972).

Fredholm and Padé approximations taken to the second order in the interaction potentials are used to evaluate elastic and inelastic cross sections for a schematic model scattering problem involving a pair of coupled channels with square well potentials. It is found that resonances occurring in the elastic cross section which arise from the presence of bound states in the second channel are described quite well by the second-order Fredholm approximation provided that the potentials are not too strong, but the [1,1] Padé approximation as well as the first and second Born approximations entirely fail to take account of these resonances. (auth)

3544 METHOD OF MODELS IN VARIATIONAL SCATTERING CALCULATIONS. Drachman, R. J. (Goddard Space Flight Center, Greenbelt, Md.). J. Phys., B (London); 5: No. 2, L30-2(Feb 1972).

In atomic scattering calculations, certain difficulties stem from the use of inexact target wave functions. These can be avoided, provided the projectile is distinguishable from the atomic electrons, by using modified forms of the atomic hamiltonian. A connection with the positron scattering work of Peterkop and Rabik is established. (auth)

3545 EXCITATION OF THE FIRST EXCITED STATE IN ARGON BY ELECTRON BOMBARDMENT. Lloyd, C. R.; Teubner, P. J. O.; Weigold, E.; Hood, S. T. (Flinders Univ. of South Australia, Bedford Park). J. Phys., B (London); 5: No. 2, L44-7 (Feb 1972).

The electron-impact excitation function of the 1048.2- and 1066.7-Å lines resulting from the decay of the first excited state in argon was measured from threshold to 180 eV. The data are compared with the plane- and distorted-wave Born approximations. (auth)

3546 BRANCH STRUCTURE IN ROTATIONAL EXCITATION BY RESONANT ELECTRON–MOLECULE COLLISIONS. Read, F. H. (Manchester Univ., Eng.). J. Phys., B (London); 5: No. 2, 255-64(Feb 1972).

By approximating Wigner 3-j and 6-j coefficients for the coupling of large angular momenta, simplified expressions were obtained for angular distributions in the excitation of rotational states in

resonant electron–molecule reactions. These simplifications have given rise to a useful classification of rotational transitions of linear molecules into branches, each of which has a characteristic energy-loss spectrum and angular distribution. (auth)

3547 THEORY OF FINE STRUCTURE TRANSITIONS IN EXCITED RUBIDIUM ATOMS COLLIDING WITH RARE GAS ATOMS. Hidalgo, M. B.; Geltman, S. (National Bureau of Standards, Washington, D. C.). J. Phys., B (London); 5: No. 2, 265-76(Feb 1972).

A theoretical model is presented for the interaction between an alkali metal atom in the first excited ^2P state and a ground state rare gas atom, which is effective in causing transitions among the alkali metal fine-structure states. The main difference from previously used models is a more detailed treatment of short-range effects including deviations from straight-line paths in the semiclassical treatment. An application to the case of Rb interacting with He, Ne, Ar, and Kr gives results for the depolarization and inelastic cross sections in reasonable accord with experiment. (auth)

3548 ELECTRON IMPACT IONIZATION OF POSITIVE IONS WITH CONFIGURATIONS $1s^22s^22p^q$. Moores, D. L. (University Coll., London). J. Phys., B (London); 5: No. 2, 286-98(Feb 1972).

Cross sections for ionization of positive ions with configuration $1s^22s^22p^q$ by electron impact are calculated in the no-exchange Coulomb–Born approximation, contributions from ejection of both 2s and 2p electrons being included. Reduced cross sections for once- and twice-ionized systems, and for the limiting case of infinite nuclear charge are evaluated, enabling cross sections for other systems to be obtained by interpolation. Comparison with experiment is made where possible, and agreement is good in all cases at high incident energies. In some cases there is evidence that the effects of autoionization, not included in this work, could be important at low energies. (auth)

3549 REPLY TO THE COMMENT ON PRADHAN'S IMPULSE APPROXIMATION. Urata, N. (Mitsubishi Chemical Industries Ltd., Kawasaki, Japan); Watanabe, T. J. Phys., B (London); 5: No. 3, L49-51(Mar 1972).

Questions regarding the validity of the Pradhan's impulse (PI) approximation raised in a letter by Coleman (J. Phys., B (London), 5: L19-20 (1972)) are answered. It is pointed out that calculation of cross sections for the processes $A^{n+} + B \rightarrow A^{(n-1)+} + B^+$ using the PI approximation gave good agreement with experiment for cases other than $H^+ + H$. It is again concluded that the PI approximation is useful as a simple estimation of the charge-transfer process. (A.G.W.)

3550 NOTE ON THE SCATTERING MATRIX IN THE IMPACT PARAMETER APPROXIMATION. Shakeshaft, R.; Macek, J. (Univ. of Nebraska, Lincoln). J. Phys., B (London); 5: No. 3, L63-6(Mar 1972).

The unitarity of the scattering matrix has long been used as a numerical check on impact-parameter calculations. The invariance of the system under time reversal provides a further numerical check. In this letter the explicit condition imposed on the scattering matrix by time-reversal invariance in the linear trajectory approximation is derived. (auth)

3551 VARIATIONAL PRINCIPLES FOR THE PHASE FUNCTION METHOD. John, T. L. (University Coll., Cardiff, Eng.). J. Phys., B (London); 5: No. 3, 438-44(Mar 1972).

An alternative variational principle for the phase function method is presented, which can be extended to include many-channel scattering and exchange effects. The connection between this approach and the Hulthén–Kohn method is discussed. (auth)

3552 DISSOCIATIVE ATTACHMENT IN HOT MOLECULES. Birtwistle, D. T. (Polytechnic of North London, London); Modinos, A. J. Phys., B (London); 5: No. 3, 445-65(Mar 1972).

A theory of resonant dissociative attachment of electrons to hot diatomic gases is presented. The molecule state is approximated by a harmonic well and the negative ion, resonant, state by a line of constant slope, and the rate of decay of the resonance is assumed independent of internuclear separation. The transition matrix elements that arise in the course of the calculation are evaluated using different approximations. The results of these approximations are compared with exact results obtained entirely numerically. The theory is used to interpret the experimental results of Fite et al., for oxygen and thereby deduce some of the properties of the system $O_2 + e$. (auth)

3553 NONRESONANT CHARGE CAPTURE: $Na^+ + Li \rightleftharpoons Na + Li^+$. Bottcher, C.; Oppenheimer, M. (Harvard Coll. Observatory, Cambridge, Mass.). J. Phys., (London); 5: No. 3, 492-6(Mar 1972).

The cross sections for the process $Na^+ + Li \rightleftharpoons Na + Li^+$ are calculated in the range 100 eV to 12 keV using a perturbed-stationary-state formulation and found to agree with experiment to the extent of reproducing detailed structure. A simple interpretation is advanced of the observed quasi-oscillatory structure. (auth)

3554 FREDHOLM INTEGRAL EQUATION METHOD FOR SCATTERING PHASE SHIFTS. Holt, A. R.; Santoso, B. (Univ. of Essex, Colchester, Eng.). J. Phys., B (London); 5: No. 3, 497-507(Mar 1972).

A method is presented for obtaining exact scattering phase shifts using an integral-equation formulation. It is similar to recent work by Reinhardt and Szabo but differs in that, in the integral equation used, no inherent singularities have to be avoided. The method was applied to both the exponential and screened Coulomb potentials and proved to be complementary to the method of numerically integrating the radial equation—this Fredholm integral method converges more quickly for nonzero angular momentum and/or high impact energies. It is, however, applicable to all angular momenta and at all energies, including the zero-energy limit. The main drawback is that knowledge of the second Born off-shell matrix elements for the potential is required. (auth)

3555 CROSS SECTIONS FOR THE EXCITATION OF THE ALKALIS Li, Na, AND K BY ELECTRON IMPACT. McCavert, P.; Rudge, M. R. H. (Queen's Univ., Belfast). J. Phys., B (London); 5: No. 3, 508-13(Mar 1972).

Values of some excitation cross sections of the alkali metals, lithium, sodium and potassium, are presented; they calculated by using a simple regional trial function in a variational principle for the R matrix. A comparison is given, where possible, between the results of these calculations and other theoretical and experimental values. The agreement between the calculations presented and the best available comparison data is found to be surprisingly good, suggesting that the other cross sections presented for which no such comparison is possible may be quite accurate also. (auth)

3556 FORMULATION OF THE IMPACT PARAMETER METHOD FOR GENERAL ATOM–ATOM COLLISIONS. Shakeshaft, R. (Univ. of Nebraska, Lincoln). J. Phys., B (London); 5: No. 3, 559-70(Mar 1972).

The impact-parameter method is formulated for general atom–atom collisions, taking full account of the electron spin. A full discussion of reflection symmetry in the scattering plane is given, and a useful relation resulting from time-reversal invariance is derived. The validity of the impact-parameter method is then investigated for the near-resonant charge-exchange process $H^+ + Xe \rightarrow H + Xe^+ (^2P_{\frac{1}{2}})$. Good agreement with experiment is obtained. (auth)

3557 PRODUCTION OF K SHELL VACANCIES IN SYMMETRIC ION–ATOM COLLISIONS. Briggs, J. S.; Macek, J. (United Kingdom Atomic Energy Research Establishment, Harwell). J. Phys., B (London); 5: No. 3, 579-88(Mar 1972).

The electron-promotion model of Fano and Lichten has been applied to the calculation of the cross section for production of K-shell vacancies in symmetric ion–atom collisions. The promotion is assumed to occur via rotational coupling between the $2p\sigma$ and $2p\pi$ molecular orbitals. Certain statistical factors that govern the probability of a vacancy occurring initially in the $2p\pi$ molecular orbital were derived. A peak in the vacancy-production probability at small impact parameters is predicted and is shown to correspond to deflection through 90°. Good agreement with experiment is obtained when the method is applied to the Ne^+–Ne system and an approximate scaling law is suggested by which the cross section for K-shell vacancy production in other symmetric collisions may be deduced. (auth)

3558 ELECTRON LOSS FROM METASTABLE HYDROGEN. Dose, V.; Gunz, R. (Univ., Zurich). J. Phys., B (London); 5: No. 3, 636-47(Mar 1972).

Cross sections for electron loss from metastable hydrogen in collisions with argon and molecular hydrogen, nitrogen, and oxygen were measured in the energy range 2 to 60 keV. The results are compared with recent experimental work of Gilbody et al., and with theoretical predictions based on the semiempirical classical impulse approximation of Bates and Walker and, in the case of hydrogen, with Born approximation calculations of Bell and Kingston. While a satisfactory agreement between theory and the present experiment is found, the measured cross sections are significantly larger than those of Gilbody et al. (auth)

3559 HIGH RESOLUTION STUDY OF THE ELECTRON IMPACT SPECTRUM OF ZINC VAPOUR AT KINETIC ENERGIES 50 TO 150 eV AND IN THE ANGULAR RANGE 0 TO 11°. Newell, W. R.; Ross, K. J. (University of Southampton, Eng.). J. Phys., B (London); 5: No. 3, 701-9(Mar 1972).

The generalized oscillator strength of the transition $4^1S \rightarrow 4^1P$

in zinc was measured at 150 eV incident-electron kinetic energy and over an angular range 1.5 to 11°. These measurements were placed on an absolute scale by normalizing to the optical oscillator strength. Absolute generalized oscillator strengths for other lines in the spectrum were obtained by normalizing to the resonance line. The reduced matrix elements ($4^1S \parallel r^2 \parallel 5^1S$) and ($4^1S \parallel r^2 \parallel 6^1S$) were found to be 6.1 au ± 15% and 2.5 au ± 30%, respectively, and the electric quadrupole transition probabilities $A_{n0}(4^1S \rightarrow 4^1D)$ and $A_{n0}(4^1S \rightarrow 5^1D)$ were calculated to be 2287 s^{-1} ± 10% and 760 s^{-1} ± 20%, respectively. (auth)

3560 ENERGY-LOSS CROSS SECTIONS FOR 500-eV ELECTRONS IN THE CONTINUUM OF O_2 AND CO. Tisone, Gary C. (Sandia Labs., Albuquerque, N. Mex.). J. Chem. Phys.; 57: No. 9, 3686-9(1 Nov 1972).

Energy-loss cross sections, differential in energy and angle, are presented for 500-eV electrons incident on O_2 and CO in the angular range of 10° to 30° for O_2 and 6° to 30° for CO. This region of the ionized continuum was studied with an energy resolution ($\Delta\epsilon/\epsilon$) of 1.5% and an angular resolution of about 1.5°. The cross sections were placed on an absolute scale by normalizing to Bromberg's elastic scattering data. Integration of the differential energy-loss cross sections over angle yielded energy-loss cross sections, differential with respect to energy, for O_2 of 0.078 a_0^2/eV at 30 eV, 0.042 a_0^2/eV at 50 eV, 0.013 a_0^2/eV at 80 eV, and 0.065 a_0^2/eV at 100 eV. Corresponding cross sections for CO were 0.0077 a_0^2/eV at 80 eV and 0.0043 a_0^2/eV at 100 eV. (auth)

3561 PROTON IMPACT DOUBLE IONIZATION OF NOBLE GAS ATOMS. Roy, B. N.; Tripathi, D. N.; Rai, D. K. (Banaras Hindu Univ., India). J. Chem. Phys.; 57: No. 9, 3904-9(1 Nov 1972).

The cross sections for proton-impact double ionization of noble gas atoms were calculated using Gryzinski's semiclassical formula. The calculated cross sections are in good agreement with experimental results. Values of the ratio σ_+/σ_{++} (single ionization cross section/double ionization cross section) were also calculated for all noble gas atoms. It is found that the calculated variation of σ_+/σ_{++} with incident proton energy agrees well with experimentally observed variation in the case of helium atom. (auth)

3562 COLLISION MATRIX ELEMENTS NEAR A PSEUDO-CROSSING OF POTENTIAL ENERGY CURVES. Oppenheimer, M. (Harvard Coll. Observatory, Cambridge, Mass.). J. Chem. Phys.; 57: No. 9, 3899-3904(1 Nov 1972).

The behavior of the matrix element of the collision operator, d/dR, between adiabatic states with variations in R, the internuclear separation, is studied qualitatively for diatomic molecules. These matrix elements often have a maximum or a zero near the pseudocrossing of the two adiabatic potential energy curves. Effects of these extremes of behavior on cross sections are considered and limits on the validity of approximations which use R-independent orbitals are developed. Finally, the effect of a second pseudocrossing on these matrix elements is analyzed. (auth)

3563 DEPENDENCE OF X-RAY YIELDS IN ARGON, KRYPTON, AND XENON UPON THE CHARGE STATE OF FLUORINE IONS AT 35.7 MeV. Macdonald, James R.; Winters, Loren; Brown, Matt D.; Chiao, Tang; Ellsworth, Louis D. (Kansas State Univ., Manhattan). Phys. Rev. Lett.; 29: No. 19, 1291-5 (6 Nov 1972).

In high-velocity ion–atom single collisions, a strong dependence of target x-ray production cross sections upon the ionic charge state has been observed. Experiments were performed in thin gas targets of argon, krypton, and xenon with 35.7-MeV fluorine ions incident in charge states +5 to +9. Production cross sections for Ar K, Kr L, and Xe L characteristic lines increase by as much as a factor of 5 with increasing incident charge state but cannot be fitted by a q^2 dependence. (auth)

3564 IMPACT-PARAMETER DEPENDENCE OF K-SHELL IONIZATION BY PROTONS. Laegsgaard, E. (Univ. of Aarhus, Denmark); Andersen, J. U.; Feldman, L. C. Phys. Rev. Lett.; 29: No. 18, 1206-8(30 Oct 1972).

The distribution in scattering angle and inelastic energy loss of protons that have ionized the K shell in a collision with an atom was studied by a coincidence technique. At low proton velocities, the angular distribution may be interpreted as an impact-parameter dependence and compared to semiclassical calculations. In particular, the predicted importance of the adiabatic distance, $r_{ad} = v/\omega$, is confirmed. (auth)

3565 BORN CROSS SECTIONS FOR THE EXCITATION OF HELIUM BY FAST PROTONS. Ojha, S. P.; Tiwari, P.; Rai, D. K. (Banaras Hindu Univ., India). Can. J. Phys.; 50: No. 19, 2253-6(1 Oct 1972).

Cross sections for excitation of helium by proton impact were calculated in the Born approximation. Transitions from the ground state to the n^1P(n = 2 and 3) states were considered. Highly accurate wave functions of the Hartree–Fock and configuration-interaction type were used to represent the ground state. Approximate wave functions due to Messmer were employed for the final states. The results are compared with other calculations and with experiments. (auth)

3566 SEVERAL NEW FEATURES IN THE RADIATION OF EXCITED NO_2 PRODUCED IN FAST COLLISIONS WITH Na ATOMS. Kempter, V.; Lorek, J.; Rai Dastidar , T. K. (Univ., Freiburg i.B.). Chem. Phys. Lett.; 16: No. 2, 310-13(1 Oct 1972).

A sputtered Na beam was used to investigate collisionally induced excitation of NO_2. The radiative lifetime was found to vary between 25 and 65 μs between 4050 and 7350 Å. The intensity of the radiation is shown to rise monotonically from approximately 4000 Å towards longer wavelengths. The threshold for excitation of radiative states of NO_2 was found to be (3.3 ± 0.3) eV for wavelengths ≥6950 Å. (auth)

3567 ELECTRON–VIBRATIONAL-DIPOLE SCATTERING. Davis, H. T. (Univ. of Minnesota, Minneapolis); Schmidt, L. D. Chem. Phys. Lett.; 16: No. 2, 260-4(1 Oct 1972).

It is shown that at low energies (less than 1 eV) inelastic electron–molecule cross sections of the order of one square angstrom may arise from electron scattering off the electric dipole moments associated with bending and stretching vibrations of the target molecule. The theory accounts qualitatively for the vibrational cross section observed in methane for electronic energies below 0.5 eV. (auth)

3568 EXCITATION OF VACUUM-ULTRAVIOLET RADIATION BY ELECTRON IMPACT ON CARBON MONOXIDE: SOME UNRESOLVED QUESTIONS NEAR THRESHOLD. Wells, W. C.; Zipf, E. C. (Univ. of Pittsburgh). J. Chem. Phys.; 57: No. 8, 3583-4(15 Oct 1972).

A time-of-flight method was used to examine the vacuum ultraviolet radiation excited by electron impact on CO in the range of 5 to 17 eV. The results are compared with results of Newton and Thomas (Chem. Phys. Lett., 11: 171(1971)). The resonance having a peak at 8.3 eV observed by Newton and Thomas was not observed in the present experiment. Possible reasons for the disparity between the two experiments are considered, but no satisfactory explanation is found. It is concluded that further investigation is warranted. (A.G.W.)

3569 COMPETITION BETWEEN DOUBLE AND SINGLE ELECTRON TRANSFER IN 2- TO 8-keV Ar^{2+}–Ar COLLISIONS. Cosby, P. C.; Moran, T. F. (Georgia Inst. of Tech., Atlanta). J. Chem. Phys.; 57: No. 8, 3569-70(15 Oct 1972).

In order to examine the competition between the single and double electron-transfer processes, a time-of-flight technique was used to measure cross sections for the two reaction channels $Ar^{2+} + Ar \rightarrow Ar^0 + Ar^{2+}$ and $Ar^{2+} + Ar \rightarrow Ar^+ + Ar^+$ over a range of kinetic energies from 1 to 8 keV. The results indicate the predominance of double electron-transfer processes below 8 keV. The cross sections for single electron transfer between 6 and 8 keV are somewhat higher than previously reported. (A.G.W.)

3570 SEMICLASSICAL COLLINEAR ATOM–OSCILLATOR COLLISIONS: AN AVERAGE OVER THE THERMAL VIBRATIONAL DISTRIBUTION. Morse, R. I. (Clark Univ., Worcester, Mass.). J. Chem. Phys.; 57: No. 8, 3528-31(15 Oct 1972).

A simple closed-form expression for the energy transfer in a collinear atom–oscillator collision averaged over a thermal distribution of initial oscillator states is given. The expression is evaluated for a He–W atomic oscillator in a semiclassical approximation. The necessity of including multiquanta transitions is shown. (auth)

3571 CLASSICAL CALCULATIONS OF H_2O ROTATIONAL EXCITATION IN ENERGETIC ATOM–MOLECULE COLLISIONS. Kolb, C. E.; Baum, H. R.; Tait, K. S. (Aerodyne Research, Inc., Burlington, Mass.). J. Chem. Phys.; 57: No. 8, 3409-16(15 Oct 1972).

Classical rotational excitation probabilities for collisions of three atomic species with H_2O were calculated using a Monte Carlo procedure. The rigid rotor approximation for H_2O is employed together with hard sphere scattering potentials permitting the excitation in a given collision to be calculated analytically. The results are applicable to high-energy (≥1 eV) collisions. A procedure for constructing differential rotational excitation cross sections is presented. (auth)

3572 ELECTRON SCATTERING BY MOLECULES WITH AND WITHOUT VIBRATIONAL EXCITATION. V. ELASTIC SCATTERING AND NONRESONANT VIBRATIONAL EXCITATION

OF N_2 AT 30 TO 83 eV. Truhlar, D. G. (Univ. of Minnesota, Minneapolis). J. Chem. Phys.; 57: No. 8, 3260-3(15 Oct 1972).

Model polarized-Born-approximation calculations are compared to all the available intermediate-energy differential-cross-section data for elastic scattering by N_2 and for electron-impact excitation of vibration in N_2. The various models predict the angle dependence of the elastic scattering differential cross sections accurately for scattering angles less than 40° to 70° at 30 and 83 eV. Vibrational excitation is found to be dominated by the polarization interaction at 33 to 50 eV. (auth)

3573 ELECTRON SCATTERING BY MOLECULES WITH AND WITHOUT VIBRATIONAL EXCITATION. IV. ELASTIC SCATTERING AND EXCITATION OF THE FIRST VIBRATIONAL LEVEL FOR N_2 AND CO AT 20 eV. Truhlar, D. G. (Univ. of Minnesota, Minneapolis); Trajmar, S.; Williams, W. J. Chem. Phys.; 57: No. 8, 3250-9(15 Oct 1972).

Normalized experimental differential cross sections for scattering angles in the range 20 to 85° are presented for elastic scattering and excitation of the fundamental vibration of N_2 and CO by electrons with impact energy 20 eV. From three of the four differential cross sections the integral cross sections can be estimated. The cross sections for N_2 are in good agreement with those of Pavlovic et al. The elastic scattering cross sections are compared to the predictions of the polarized Born approximation using five model potentials (including polarization) previously proposed for N_2 or CO. The model of Crawford and Dalgarno is in good agreement with experiment and the model of Sampson and Mjolsness can be put in good agreement by changing an empirical "cut-off parameter" by about $0.5a_0$. The vibrational excitation of N_2 appears to be dominated by resonance scattering, as originally suggested by Pavlovic et al. It is shown that the vibrational excitation of CO also appears to be dominated by resonance scattering. (auth)

3574 DISSOCIATIVE ATTACHMENT IN CARBON DIOXIDE. Chantry, P. J. (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys.; 57: No. 8, 3180-6(15 Oct 1972).

The production of O^- from CO_2 by dissociative attachment was studied with electrons having energies in the range 0 to 20 eV. In addition to the two already well-established peaks in the 0- to 10-eV range, a third peak was substantiated at 13 eV. At room temperature the 13-eV peak cross section is approximately 6×10^{-21} cm^2, rising to approximately 2×10^{-20} cm^2 at 1000°K. Measured O^- ion kinetic energy distributions corresponding to the three processes peaking at 4.4, 8.2, and 13.0 eV are presented and their relevance to previous work is discussed. In all three processes only the high-energy tails of the ion energy distributions are found to be sensitive to electron energy, with a decreasingly small fraction of the available energy appearing as kinetic energy of separation of the fragments. In this respect the results are similar to previous measurements of O^- production from N_2O. (auth)

3575 FORMATION OF CALCIUM IONS BY CHARGE TRANSFER. Rutherford, J. A.; Mathis, R. F.; Turner, B. R.; Vroom, D. A. (Gulf Radiation Tech., San Diego, Calif.). J. Chem. Phys.; 57: No. 8, 3087-90(15 Oct 1972).

Charge-transfer cross sections were measured in the energy range from 1 to 500 eV for nine common atmospheric ions in collision with neutral calcium atoms. The ions studied are O^+, N^+, N_2^+, NO^+, O_2^+, H_2O^+, H_3O^+, N_2O^+, and Ca^+. In all cases the cross sections are found to be large indicating near-resonant processes. Mechanisms consistent with this observation are given. Extrapolation of the measured cross sections to thermal energies was also carried out. (auth)

3576 FORMATION OF IRON IONS BY CHARGE TRANSFER. Rutherford, J. A.; Vroom, D. A. (Gulf Radiation Tech., San Diego, Calif.). J. Chem. Phys.; 57: No. 8, 3091-3(15 Oct 1972).

Reactions of iron atoms with common atmospheric ions were studied in the energy range from 2 to 500 eV. The ions considered were H^+, O^+, N^+, N_2^+, NO^+, O_2^+, H_2O^+, and H_3O^+. With the exception of one proton-transfer reaction, all of the processes studied involved charge transfer. All but one of the charge-transfer reactions were found to have large cross sections over the total energy range and probably proceed by near-resonant energy paths. Where possible the measured cross sections were extrapolated to thermal energies. (auth)

3577 VACUUM ULTRAVIOLET EXCITATION OF H(2p) BY ELECTRON IMPACT ON H_2. McConkey, J. W.; Donaldson, F. G. (Univ. of Windsor, Ont.). Can. J. Phys.; 50: No. 18, 2211-6(15 Sep 1972).

"Polarization-free" measurements are presented of the electron-impact excitation of Lyman-α by electron impact on H_2 in the energy range 20 to 2000 eV. Cross sections are made absolute by normalizing to the data of Mumma and Zipf at 100 eV. A broad maximum in the function occurs around 60 eV, some 20 eV lower than was found by some previous workers. Reasons for this discrepancy are discussed. The high-energy behavior of the cross section is analyzed in terms of the Bethe approximation, and a value of 0.11 is obtained for the square of the dipole matrix element of the transitions involved. (auth)

3578 CALCULATION OF ABSORPTION AND ELASTIC CROSS SECTIONS USING THE OPTICAL POTENTIAL. Allison, Arthur C. (Smithonian Astrophysical Observatory, Cambridge, Mass.). Comput. Phys. Commun.; 3: No. 3, 173-9(1972).

Cross sections for absorption and elastic scattering of particles by a center of force are given in terms of the real and imaginary parts of the phase shift obtained from the solution of the Schroedinger equation with a complex potential. The program presented is similar to one published earlier by Smith (Comput. Phys. Commun., 1: 106(1969)), but it permits greater flexibility in the form of the potential and also uses an improved Numerov scheme for integrating the differential equations. The computation time of the numerical integration is halved because of the symmetry of the problem and the use of the iterative Numerov method. The time depends critically on the number of points in the integration mesh. (A.G.W.)

3579 FINE STRUCTURE CROSS SECTIONS FROM REACTANCE MATRICES. Saraph, H. E. (University Coll., London). Comput. Phys. Commun.; 3: No. 3, 256-68(1972).

The reactance matrices obtained from calculations in L–S coupling are transformed to compute collision strengths for transitions between fine-structure levels. The data are sorted and checked. The R matrices are transformed to pair coupling using algebraic recoupling coefficients. Moreover, the R matrices may be transformed to allow for intermediate coupling in the target if the required transformation coefficients are available. The collision strengths are computed from the R matrices using matrix algebra. Use of double precision is recommended, but instructions for conversion to single precision are given. (A.G.W.)

3580 SPECTRA OF Ar AND (Ar,O_2) MIXTURE EXCITED BY LOW-ENERGY PROTON BOMBARDMENT. Ghosh, S. N.; Sahai, Y.; Bhutani, K. K. (Univ. of Allahabad, India). Indian J. Pure Appl. Phys.; 10: No. 4, 296-301(Apr 1972).

Excited spectra of pure Ar and a mixture of (Ar, O_2) bombarded by low-energy protons (0.56 to 1.7 keV) at different gas pressures (5 to 30 μ) were studied spectroscopically, photometrically, and microphotometrically. In the spectral region 2900 to 7000 Å, it was observed that, for argon, Ar–I lines are excited and, for (Ar, O_2) mixture, Ar–I lines, Balmer lines, and the 1NG system of O_2^+ are excited. For the Ar–I lines, the intensity increases with the proton energy and is found to vary linearly with the pressure of the bombarded gas. For O_2^+ bands, the intensity is found to vary (i) inversely with the proton energy, (ii) directly with the increase of the O_2 content when the total pressure of the mixture remains constant, and (iii) directly with the total pressure of the mixture. Relative intensities for certain prominent emissions for Ar–I lines and the ratio of the intensities of Hα and Hβ for different proton energies were calculated. Mechanisms for excitation of different emissions are proposed. (auth)

3581 SELF-IONIZATION OF ARGON BY SLOW ELECTRON IMPACT. Peresse, J.; Gelebart, F.; Le Nadan, A. (Univ., Brest, France). Compt. Rend., Ser. B; 275: No. 7, 255-7(16 Aug 1972). (In French).

The self-ionizing states of Ar were observed by detecting the scattered electrons and the ejected electrons in an electron–argon collision experiment. The Fano profiles were calculated for certain corresponding levels. (France)

3582 POSITRONIUM FORMATION IN POSITRON–HYDROGEN COLLISIONS. Wakid, S. E. A.; LaBahn, R. W. (Louisiana State Univ., Baton Rouge). Phys. Rev., A.; 6: No. 6, 2039-49 (Dec 1972).

The Harris–Nesbet algebraic close-coupling method is used to calculate the S-wave phase shift and positronium-formation cross section for various types of close-coupling expansions of the total wave function. The positronium channels are included explicitly, and polarization effects, in both the hydrogen and positronium atoms, are incorporated by pseudostates that give the correct static polarizabilities. (auth)

3583 ELECTRON MOMENTUM-TRANSFER CROSS SECTION IN CESIUM. Nighan, W. L. (United Aircraft Research Labs., East Hartford, Conn.); Postma, A. J. Phys. Rev., A.; 6: No. 6, 2109-17(Dec 1972).

An analysis of electron drift-velocity data in cesium was conducted in order to determine the electron momentum-transfer cross section. Numerical evaluation of the drift-velocity integral

using numerous trial functions for the cross section revealed the qualitative and semiquantitative nature of the electron momentum-transfer cross section in cesium. The cesium cross section found to be most consistent with the available experimental data exhibits considerable variation with electron energy in the range 0.1 to 1.0 eV, the region of primary importance in plasma applications. (auth)

3584 VARIATIONAL CALCULATIONS ON ELECTRON–HELIUM SCATTERING. Sinfailam, A. L.; Nesbet, R. K. (IBM Research Lab., San Jose, Calif.). Phys. Rev., A.; 6: No. 6, 2118-25(Dec 1972).

Calculations were made on the elastic scattering of low-energy electrons by helium using a variational procedure that takes polarization and correlation effects into account by means of continuum Bethe–Goldstone equations. The convergence of the results is examined using two methods to obtain a complete set of basis functions. Results for the s, p, d, and f waves are presented. The width of the ^2S closed-channel resonance below the n = 2 threshold is found to be 0.015 eV, in comparison with the 0.015- to 0.020-eV estimates of Andrick and Ehrhardt from experiment and the 0.01-eV estimate of Simpson and Fano. (auth)

3585 EXACT CALCULATION OF THE SECOND-ORDER BORN TERMS FOR PROTON–HYDROGEN ELECTRON-TRANSFER COLLISIONS. Kramer, P. J. (Louisiana State Univ., Baton Rouge). Phys. Rev., A.; 6: No. 6, 2125-30(Dec 1972).

The four second-order terms in the Born series for the proton–hydrogen electron-transfer problem are analytically reduced from six-dimensional to three-dimensional integrals. No mass approximations are made. This permits an accurate numerical calculation of the total cross section to second order. Numerical results are given from 0.1 to 2.5 MeV. The complete second-order cross section reduces the first-order results by 30% from 1 to 2.5 MeV. The various first- and second-order Born approximations for this problem are discussed. (auth)

3586 MICROSCOPIC OPTICAL-MODEL ANALYSIS OF ELECTRON SCATTERING FROM ATOMIC HYDROGEN. Alton, G. D.; Garrett, W. R.; Reeves, M.; Turner, J. E. (Oak Ridge National Lab., Tenn.). Phys. Rev., A.; 6: No. 6, 2138-46(Dec 1972).

The projection-operator formalism advanced by Feshbach is used to derive a numerically tractable equation that describes the elastic scattering of electrons from atomic hydrogen under multichannel conditions. By neglecting the potential of interaction in the inverse operator, analytical expressions can be obtained for the Green's function which permit the inclusion of both discrete and continuum target-state contributions to the optical potential. The numerical procedures used to solve the resulting nonlocal integrodifferential equation and to generate differential, total elastic and inelastic cross sections are discussed. Good agreement is found with available experimental data. (auth)

3587 INELASTIC S-WAVE POSITRON–HYDROGEN SCATTERING. Stein, J.; Sternlicht, Raphael (Hebrew Univ., Jerusalem). Phys. Rev., A.; 6: No. 6, 2165-9(Dec 1972).

The variational methods of Kohn and Hulthén are used to calculate the scattering parameters of the positron–hydrogen rearrangement collision. The R-matrix elements are computed for positron energies 0 to 0.33 au with an accuracy of 1 to 10%. It is also shown that a good approximation to the diagonal elements of the R matrix can be obtained by ignoring the coupling between the channels. (auth)

3588 ELECTRON-IMPACT EXCITATION AND IONIZATION OF ATOMIC OXYGEN. Kazaks, P. A.; Ganas, P. S.; Green, A. E. S. (Univ. of Florida, Gainesville). Phys. Rev., A.; 6: No. 6, 2169-80(Dec 1972).

The analytic atomic independent-particle model (IPM) of Green, Sellin, and Zachor was used to calculate generalized oscillator strengths (GOS) and total cross sections for excitation and ionization of atomic oxygen. First single-particle levels were obtained by averaging over the experimental energy levels within a multiplet. Then the two parameters of the IPM potential were adjusted so that it accurately characterizes the ground state and 15 lowest excited states. Using the wave functions so obtained and assuming the Born approximation and the LS-coupling scheme, absolute GOS and cross sections for excitation to these levels and for ionization with incident energies up to 1000 eV and secondary electron energy up to 200 eV were calculated. An analytic representation of the excitation GOS as a function of the momentum transfer was obtained. An analytic representation of the energy differential cross section for ionization as a function of the energies of the incident and secondary electrons was also obtained. Comparison is made with available experimental data and other calculations. (auth)

3589 DISSOCIATIVE EXCITATION OF MOLECULAR HYDROGEN BY ELECTRON IMPACT. Misakian, Martin; Zorn, J. C. (Univ. of Michigan, Ann Arbor). Phys. Rev., A.; 6: No. 6, 2180-96(Dec 1972).

Dissociative excitation of molecular hydrogen can proceed via the process $H_2 + e \rightarrow H(2s) + H + e$ and yield metastable H(2s) atoms that have kinetic energies near 0.3 eV ("slow") or near 4 eV ("fast"). The dissociation process has been studied using a pulsed electron gun with an energy resolution of ± 0.3 eV and using a metastable atom detector capable of viewing H(2s) atoms with an angular resolution of 1° over a range 60° to 120° with respect to the electron-beam direction. The measurement of the angular intensity distribution gives information about the final states involved in the dissociation process. For slow H(2s) atoms, the electron energy threshold for production of the least energetic of the slow metastable atoms is 14.6 ± 0.3 eV. The excitation function and the angular distribution of the slow H(2s) atoms suggest that the $B'\ ^1\Sigma_u^+$, $e\ ^3\Sigma_u^+$, $D\ ^1\Pi_u^+$, and $d\ ^3\Pi_u^+$ excited states are involved in the formation of these metastable fragments. For fast H(2s) atoms, the electron energy threshold for production of the least energetic of the fast H(2s) atoms is near 29 eV. The angular distribution data would indicate that these atoms arise from a $^1\Pi_u$ state; the form of the excitation function indicates that the parent state has a multiplicity of 1. The change in energy distribution of the fast H(2s) atoms, measured as a function of electron-gun voltage, supports the view that the $^1\Pi_u$ state is a previously unreported doubly excited state that has an asymptotic energy of 24.9 eV. (auth)

3590 DIRECT DERIVATION OF THE THRESHOLD BEHAVIOR OF ATOM–ATOM PARTIAL-WAVE AMPLITUDES FROM THE WORK OF FEINBERG AND SUCHER. Beers, B. L. (Southern Illinois Univ., Carbondale). Phys. Rev., A.; 6: No. 6, 2486-7(Dec 1972).

Using only the analytic structure of the amplitude for atom–atom scattering as derived by Feinberg and Sucher, a direct derivation of the threshold behavior of the partial-wave amplitudes is given. The behavior is, as expected, characteristic of scattering from an R^{-7} potential. (auth)

Atomic Theory

Refer also to abstracts 3523 and 3539.

3591 PERTURBATION THEORY FOR THE RELATIVISTIC HARTREE–FOCK EQUATIONS FOR ATOMS. II. THE MAGNETIC INTERACTION. Bowtell, G. (Univ. of London). J. Phys., B (London); 5: No. 1, 2-6(Jan 1972).

The work of Sharma and Bowtell in 1970 was extended to take into account the magnetic interaction in a relativistic Hartree–Fock treatment of the two-electron atom. Also the results of calculations for the relativistic corrections to the ground state of the first 20 elements of the helium isoelectronic sequence, based wholly on the zero- and first-order energy parameters, are reported. (auth)

3592 POLARIZED PSEUDOSTATE CALCULATIONS FOR A COMPLEX ATOM. Vo Ky Lan (Observatoire de Paris, Meudon, France). J. Phys., B (London); 5: No. 2, 242-9(Feb 1972).

Calculation of the perturbed orbital wave function chosen to give the full polarizability of the ground and excited states of a complex atom is considered. A new numerical technique is described and tested on the hydrogen atom, where all polarized wave functions are analytic and known exactly. The accuracy obtained covers at least four significant places. Applications of these pseudostates to the modified close-coupling expansion are considered elsewhere. (auth)

3593 COMMENTS ON PRADHAN'S IMPULSE APPROXIMATION. Coleman, J. P. (Univ. of Durham, Eng.). J. Phys., B (London); 5: No. 2, L19-20(Feb 1972).

Conclusions reached by Urata and Watanabe (J. Phys., B (London), 4: L121-5(1971)), that Pradhan's impulse approximation for the process $H^+ + H(1s) \rightarrow H(1s) + H^+$ represents the velocity dependence of the cross section properly and may be useful for rather simple estimation of the charge-transfer cross section, are refuted briefly. (A.G.W.)

3594 EFFECT OF ATOMIC AND EXTRA-ATOMIC RELAXATION ON ATOMIC BINDING ENERGIES. Shirley, D. A. (Univ. of California, Berkeley). Chem. Phys. Lett.; 16: No. 2, 220-5 (1 Oct 1972).

An equivalent-cores-relaxation model is given for calculating atomic binding energies from orbital energies using only ground-state atomic properties. The agreement with experiment is excellent for the noble gases. On the basis of present knowledge of

atomic relaxation, the phenomenon of "extra-atomic relaxation", in which electronic charge is attracted toward a hole-state atom, is shown to have an important effect in lowering atomic core-level binding energies in condensed phases. This will affect the interpretation of most core-level binding energies measured to date. (auth)

3595 LOW-ENERGY PHOTOIONIZATION. Henry, E. M.; Bates, C. L.; Veigele, W. J. (Kaman Sciences Corp., Colorado Springs, Colo.). Phys. Rev., A.; 6: No. 6, 2131-8(Dec 1972).

Low-energy photoionization cross sections for the elements hydrogen through plutonium were calculated using a nonrelativistic single-particle model. Initial-atom and final-ion wave functions were developed from the Hartree–Fock equations using Slater's free-electron exchange approximation. Core relaxation was included approximately by using experimental binding energies in the Schrödinger equation for the continuum electron. Subshell contributions and total-cross-section calculations for the noble gases are compared with Hartree–Fock values with complete exchange. Total cross sections are compared with experiments for low-, medium-, and high-atomic-number elements. (auth)

3596 RELATION BETWEEN THE ISOTOPE OR ISOMER SHIFT AND THE NUCLEAR-CHARGE DISTRIBUTION. Dunlap, B. D. (Argonne National Lab., Ill.). Phys. Rev., A.; 6: No. 6, 2057-8(Dec 1972).

It is shown, for a model in which the nuclear-charge distribution is that of a uniformly charged sphere of radius R, that the isotope or isomer shift is proportional to R^k where $k = 1 + (1 - \alpha^2 Z^2)^{1/2}$. (auth)

3597 FERMI–SEGRE FORMULA. Froeman, Nanny; Froeman, P. O. (Univ. of Uppsala,). Phys. Rev., A.; 6: No. 6, 2064-7(Dec 1972).

For a nonrelativistic quantal particle moving with the angular momentum $l = 0$ in a spherically symmetric, smooth potential well, which in the neighborhood of the center of force gives rise to an attractive Coulomb force, a formula for the probability density of the particle at the center of force is derived by means of certain phase-integral approximations of an arbitrary order. From this formula, which is expected to be very accurate, the nonrelativistic approximation of the Fermi–Segrè formula for the probability density of finding an s electron at the nucleus of an atom or ion is obtained. The limits of validity of the Fermi–Segrè formula in the nonrelativistic approximation are clarified by this derivation. (auth)

3598 THEORETICAL APPROACH TO THE CALCULATION OF ENERGIES AND WIDTHS OF RESONANT (AUTOIONIZING) STATES IN MANY-ELECTRON ATOMS. Nicolaides, C. A. (Yale Univ., New Haven). Phys. Rev., A.; 6: No. 6, 2078-92 (Dec 1972).

A theoretical approach, capable of providing quantitative results for N-electron nonrelativistic "nonstationary" states, is presented. Inner-hole or doubly excited states, observed in various types of experiments, are treated from a conceptually single point of view, as decaying states. First, the relevant important quantities already known, e.g., from Feshbach's theory, are derived and interpreted in a mathematically and physically meaningful way. Then the exact square-integrable N-electron function describing the initial localized N-electron state is considered and, from straightforward variation-perturbation-theory considerations, a variational minimum principle is derived, which permits one to incorporate systematically the important correlation effects without the danger of a "variational collapse." This method requires projection into known one-electron zeroth-order functions, and it thus overcomes the difficulties of the well-known P, Q methods, which require projection onto exact wave functions. From preliminary N-body calculations the $He^{-2}P^0$ and ^2D resonances, previously observed experimentally, at about 57.3 and 58.4 eV are found. In addition, the positions of various autoionizing states are predicted: in Li I at about 140.7 eV (a^2P^0 state), in C IV at about 306.7 eV (^2D), in N I at about 14.9 eV (^2D), and in F I at about 22.4 eV (^2S) above the ground state. These states, which are just samples of states treatable by this approach, may in principle cause observable structures, e. g., in photon-absorption experiments, in particle–atom scattering experiments, or in beam-foil experiments. (auth)

3599 REMARKS ON BRILLOUIN'S THEOREM IN THE ATOMIC VARIATIONAL APPROACH. Bauche, J.; Klapisch, M. CNRS, Orsay, France). J. Phys., B (London); 5: No. 1, 29-36 (Jan 1972).

An analysis is made of the validity of Brillouin's theorem for atomic Hartree–Fock (HF) results. Consequences are derived for the use of the multiconfigurational HF method. Brillouin's theorems adapted to the unrestricted HF methods are recalled. As an application, the quality of HF results in hyperfine-structure and isotope-shift problems is discussed. The computation of screening factors for field isotope shift is shown to be the most favorable case. (auth)

PHYSICS (ELECTROFLUID AND MAGNETOFLUID)

3600 PROPAGATION OF MAGNETOHYDRODYNAMIC SHOCK WAVES IN A MEDIUM OF DECREASING DENSITY. Kalmykov, Yu. K.; Rumyantsev, A. A. (Leningrad Polytechnic Inst.). Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 24-7(1972). (In Russian).

Conditions for the development of instability of a shock wave front are elucidated for the propagation of a shock wave in a medium of decreasing density and in the presence of a magnetic field. Under laboratory conditions the development of instability of a front, associated with a breakdown of these conditions, may be suppressed by the diffusion of a section of the front toward the boundaries of the system. The instability under investigation may be manifest, for example, in certain astrophysical objects. (tr-auth)

3601 INFINITE CONDUCTIVITY IN GENERAL RELATIVISTIC MAGNETOHYDRODYNAMICS. Mason, D. P. (Univ. of Witwatersrand, Johannesburg). J. Phys., A (London); 5: No. 10, L91-2(Oct 1972).

It is pointed out that in general relativistic magnetohydrodynamics Ohm's law does not determine the current density J^a in the limit of infinite conductivity, but that it is determined by the electromagnetic field equation as in nonrelativistic magnetohydrodynamics. It is also shown that the relation $2\omega \cdot H = \epsilon$ derived by Yodzis (Phys. Rev. D3: 2941(1971), assuming $J^a = \epsilon u^a$ for infinite conductivity, can also be obtained by a modified argument if the above view is taken. (auth)

3602 NONLINEAR BOUNDARY-VALUE PROBLEM FOR A CONDUCTING SOURCE FLOW IN AN INHOMOGENEOUS MAGNETIC FIELD. Wilhelm, H. E. (Colorado State Univ., Ft. Collins). Can. J. Phys.; 50: No. 19, 2327-37(1 Oct 1972).

A closed form solution in terms of elliptic functions is given for a nonlinear boundary-value problem describing a conducting viscous fluid, which flows between plane divergent walls across an azimuthal magnetic field. The conducting fluid is injected through an inner circular section (source) and removed downstream through an outer circular section (sink). The magnetic field has its sources in an external current flowing parallel to the line at which the extended walls would intersect. It is shown that the flow exhibits regions of forward and backward fluid motion in the general case. The separation of the boundary layer occurs if the angle of inclination of the walls is larger than a critical value, which depends on the source or sink strengths of the flow and the magnetic field current. Separation is inhibited by the magnetic field at sufficiently large Hartmann numbers. (auth)

3603 APPROXIMATION METHOD FOR THE CALCULATION OF FORCES ACTING ON CONDUCTING BODIES IN A TRAVELING MAGNETIC FIELD AND ITS PHYSICAL INTERPRETATION. Krumins, J. K. Magn. Gidrodin.; No. 2, 97-102(1972). (In Russian).

A simple graphic method, yielding values within an accuracy of a few percent, was developed to determine the electromagnetic forces acting on conducting bodies within a traveling magnetic field at any arbitrarily chosen magnetic Reynold's number. Application of the method presupposes that the fundamental characteristics of the dependence of the relative force on the magnetic Reynold's number are known. The determination of these characteristics is also outlined. Data concerning the value of the coefficients are presented in tabular form, making also references to the author's previous publications, in which the data were similarly applied. The physical processes taking place in conductors in a traveling magnetic field are analyzed. (TTT)

3604 ANISOTROPIC WAVE MOTIONS UNDER UNIFORM MAGNETIC AND CURRENT FIELDS. Debnath, L. (East Carolina Univ., Greenville, N. C.). Indian J. Pure Appl. Math.; 3: No. 2, 179-91(Mar 1972).

An investigation is made into anisotropic and axisymmetric wave motions generated by an arbitrary harmonic pressure distribution acting on the free surface of an inviscid, incompressible, and electrically conducting fluid in the presence of uniform magnetic and current fields. The problem is formulated as an initial-value problem, which is then solved by the joint Laplace and the generalized Hankel transforms treatment in conjunction with asymptotic methods. An integral as well as asymptotic solution of the problem related to certain pressure distributions of physical interest is presented. It is shown that the wave motions are anisotropic and dispersive and the anisotropy is entirely due to the inclusion of the magnetohydrodynamic body force. A detailed discussion of the axisymmetric wave motions, including the effects of the imposed magnetic and current fields on the flow, is presented. In addition, it is shown that the present method of solution provides an interesting illustration of the applicability of generalized functions in hydromagnetic wave problems. (auth)

3605 UNSTEADY LAMINAR MOTION OF AN ELECTRO-CONDUCTING LIQUID UNDER THE ACTION OF A TRANSVERSE MAGNETIC FIELD. Shah, K. N. (Bhavan's R. A. Coll. of Science, Ahmedabad, India). Indian J. Pure Appl. Math.; 3: No. 2, 306-12(Mar 1972).

Steady laminar motion of an electric-conducting liquid between two parallel planes under a transverse magnetic field has been discussed by Cowling, Ferraro, and others. Here, an attempt is made to discuss the unsteady motion. When the pressure gradient together with external force in the direction of motion is constant, the motion is steady, but if it is time-varying the motion is unsteady. The method of Laplace's transform was applied. Special cases are discussed when the time-varying pressure gradient together with external force is constant and when it is exponential in time. (auth)

PHYSICS (HIGH-ENERGY)

3606 ELECTRON-IMPACT EXCITATION CROSS SECTIONS FOR ATOMIC OXYGEN: $^3P-3s^3S^0$. Rountree, S. P.; Henry, R. J. W. (Louisiana State Univ., Baton Rouge). Phys. Rev., A.; 6: No. 6, 2106-9(Dec 1972).

Electron-impact excitation cross sections for O I ($^3P-3s^3S^0$) are calculated in unitarized Born, nonexchange, and close-coupling approximations. The close-coupling cross sections have the same energy dependence as measurements by Stone and Zipf but are lower in magnitude by a factor of 4. Two autodetaching levels of $O^-[2p^3(^4S^0)3s3p\ ^{2,4}P]$ are found at 9.67 and 9.94 eV. The doublet state is tentatively identified as a state found experimentally by Edwards at 9.52 eV. (auth)

Particle Interactions and Properties (Experimental)

Refer also to abstract 3078.

Electromagnetic

Refer also to abstract 3886.

3607 (BNL-17278) EXPERIMENTS IN THE ELECTRON-PROTON OPTION. Odian, Allen (Brookhaven National Lab., Upton, N. Y.). 28 Sep 1972. 4p. Dep. NTIS.

The experimental requirements for $e^- + p$ and $e^+ + p$ interactions in colliding beams are discussed, and the characteristics for a detector for such interactions are briefly stated. (J.F.P.)

3608 (CEAL-3063-2) INITIAL RESULTS ON e^+e^- INTERACTIONS AT E_{cm} = 4 GeV, AT THE CEA. Averill, R.; Hofmann, A.; Koch, J.; (and others) (Cambridge Electron Accelerator, Mass.). Sep 1972. Contract AT(11-1)-3063. 27p. (CONF-720923-5). Dep. NTIS.

From sixteenth international conference on high energy physics; Chicago, IL. (6 Sep 1972).

The $e^+ + e^-$ interactions at 4 GeV in colliding beams are studied. Cross sections for $e^+ + e^- \rightarrow e^+ + e^-$, and $e^+ + e^- \rightarrow 2\gamma$ interactions are given. Also the measured and total cross sections and average charged multiplicity for $e^+ + e^- \rightarrow$ hadrons interactions are found. (J.F.P.)

3609 (CONF-710816-25) PHOTON EXCITATION OF THE BARYON RESONANCES. Armstrong, T. A.; Hogg, W. R.; Lewis, G. M.; (and others) (Glasgow Univ. (Scotland). Dept. of Natural Philosophy). [1971]. 8p. Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, NY. (23 Aug 1971).

The total photon-proton cross section for hadron production, σ_T, was measured for tagged γ-rays for the region 0.275 to 4.225 GeV using narrow energy bins. (auth)

3610 (CONF-710816-26) INCLUSIVE YIELDS OF π^+, π^-, K^+, AND K^- FROM H_2 PHOTOPRODUCED AT 18 GeV AT FORWARD ANGLES. Boyarski, A. M.; Coward, D.; Ecklund, S.; Richter, B.; Sherden, D.; Siemann, R.; Sinclair, C. (Stanford Linear Accelerator Center, Calif.). [nd]. 8p. Dep. NTIS.

From International symposium on electron and photon interactions at high energies; Ithaca, N. Y. (23 Aug 1971).

Preliminary measurements of the invariant cross section $E(d^3\sigma/d^3P)$ for $\gamma p \rightarrow \pi^{\pm}X$ and $\gamma p \rightarrow K^{\pm}X$, for transverse momenta up to 2 GeV and for values of $x(= 2P_{||}^{cm}/\sqrt{s})$ between -0.1 and 0.8 are presented. A bremsstrahlung subtraction was used to obtain 18-GeV cross sections. The cross section falls off exponentially with transverse momenta from approximately 0.5 to 2 GeV/c. The longitudinal dependence is slowly varying, being nearly constant near x = 0 and dropping typically by a factor of 2 at x = 0.8. (auth)

3611 (CONF-710816-27) PRODUCTION OF THE ρ^0 MESON WITH TAGGED GAMMAS AT 5 GeV. Derado, I.; Kronseder, G.; Schacht, P. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). [1971]. 12p. Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, NY. (23 Aug 1971).

Results are given for ρ^0 production in $\gamma + p \rightarrow \pi^+ + \pi^- + p$ interactions at 4.2 to 6.2 GeV with tagged photons. A streamer chamber is used. Production and differential cross sections and mass and angular distributions are found. Also the $\gamma\rho^0$ coupling constant is evaluated. (J.F.P.)

3612 (CONF-710816-28) MEASUREMENT OF THE REACTION $\gamma p \rightarrow p\pi^+\pi^-$ WITH TAGGED PHOTONS OF 3 TO 6 GeV IN A STREAMER CHAMBER AT DESY. Dittmann, P.; Knobloch, J.; Rabe, E.; (and others) ([Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)]). 1971. 22p. Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, NY. (23 Aug 1971).

The reaction $\gamma p \rightarrow p\pi^+\pi^-$ was measured in a 1-m streamer chamber with a liquid-hydrogen target in a tagged photon beam at DESY. Of the 2083 ρ^0 mesons obtained, results are given in the three energy intervals 3.1 to 4.0 GeV, 4.1 to 5.0 GeV and 5.0 to 6.2 GeV. (auth)

3613 (CONF-710816-30) PROTON COMPTON EFFECT IN THE REGION OF THE $\Delta(1236)$-RESONANCE. Genzel, H.; Jung, M.; Rausch, K. R.; Wedemeyer, R.; Weyer, H. J. (Bonn Univ. (West Germany). Physikalisches Institut). May 1972. 12p. Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, NY. (23 Aug 1971).

A measurement of differential cross sections for the elastic photon proton scattering $\gamma + p \rightarrow p' + \gamma'$ in the energy region of the first resonance is described. The final results of this experiment-excitation curves at 130, 110, 90, and 70° and three cross sections at 60 and 50° are presented. (auth)

3614 (CONF-710816-33) INCLUSIVE REACTION $\gamma p \rightarrow \pi^- +$ ANYTHING IN THE ENERGY RANGE FROM 3 GeV TO 6.3 GeV. Struczinski, W.; Derado, I.; Dittmann, P.; (and others) ([Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)]). [1971]. 9p. Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, NY. (23 Aug 1971).

The momentum distribution of π^- mesons in the reaction $\gamma p \rightarrow \pi^- +$ anything is reported. The data are from a photoproduction experiment in a streamer chamber. Because a tagged photon beam was used, the energy of the incoming photon is known to ±60 MeV. The distributions of the longitudinal and transverse momentum components show no significant energy dependence. When the distributions are normalized to the total cross section $\sigma_{TOT}(\gamma p)$, their absolute values and shapes are nearly the same as obtained by other experiments with hadron beams. This result is interpreted as evidence for scaling behavior in photoproduction. (auth)

3615 (DNPL/R-19) LEPTON AND PHOTON PHYSICS IN EUROPE. Proceedings of the Daresbury Study Weekend No. 4, 1-3 October 1971. Donnachie, A. (ed.) (Daresbury Nuclear Physics Lab. (England)). 1971. 241p. (CONF-711055).

Nine papers were presented, separate abstracts for all of which were prepared. (UK)

For abstracts of individual papers see: 3075, 3322, 3616-3620, 3638, and 3886.

3616 (DNPL/R-19, pp 1-8) INTRODUCTION TO THE DARESBURY LABORATORY STUDY WEEKEND ON LEPTON AND PHOTON PHYSICS IN EUROPE. Ashmore, A. (Daresbury Nuclear Physics Lab., Eng.). 1971.

From Proceedings of the Daresbury study weekend; Daresbury, England (1 Oct 1971).

A general introductory review is made of the fields of study assigned to this conference. The photo- and electroproduction of hadrons is mainly discussed. (UK)

3617 (DNPL/R-19, pp 9-38) EXPERIMENTAL PROGRAMME AT BONN. Knop, G. (Univ., Bonn). 1971.

From Proceedings of the Daresbury study weekend; Daresbury, England (1 Oct 1971).

The work at the University of Bonn has been centered around two electron synchrotrons with maximum energies at 500 MeV and 2.5 GeV respectively. With the smaller machine the experimental work since 1958 has largely been devoted to the photoproduction of pions. Cross sections for π^0 and π^+ production and the polarization of the recoil nucleons was investigated over a wide range of angles and energies. Other work was concerned with nuclear structure physics, starting with the photodisintegration of deuterons, where cross sections and polarizations were measured. The larger machine came into operation in 1967 and pion investigations were extended to higher energies; η and K^+ meson production on hydrogen were added as new studies. The extracted electron beam was first used for studies on the elastic scattering of electrons on protons. A short description is given of the two machines, together with details of the experimental program. 18 references. (UK)

3618 (DNPL/R-19, pp 39-61) EXPERIMENTAL PROGRAMME AT THE DARESBURY LABORATORY. Gabathuler, E. (Daresbury Nuclear Physics Lab., Eng.). 1971.

From Proceedings of the Daresbury study weekend; Daresbury, England (1 Oct 1971).

The experimental program of the Daresbury Laboratory is based on the 5-GeV electron synchroton "NINA", parameters and special features of which are given. Experiments that were carried out are in the two main categories of photoproduction and electroproduction. These experiments fall naturally into two energy regions, the resonance region and the higher energy region. This is illustrated by total cross section measurements on H_2, showing that the changeover appears to occur in the 2 to 3 GeV region. A large part of the experimental work is concerned with investigation of single pion photoproduction and electroproduction from the resonance region up to the highest energy available, and the information obtained by the various measurements at the same energies can be used to provide a set of connected experimental data for extraction of amplitudes. A comparison between pion photoproduction and pion-nucleon scattering is presented, illustrating the experimental measurements required if any real advance is to be made in the understanding of the electromagnetic interaction with hadrons. An experiment on ω-photoproduction using a tagged photon beam is also described and the same tagged beam was used to measure the total photon hadronic cross section in H_2, D_2 and complex nuclei. The bremsstrahlung photon beam is being used to study π^0 production off polarized protons at 4 GeV. An experiment to measure recoil proton polarization in the photon energy range 0.85 to 1.25 GeV was performed, and angular distributions in this energy interval were studied. Work on electroproduction is also described, including electroproduction on the first resonance region and pion form factor determination at higher energies; also measurements of positive charged pion electroproduction near threshold. Angular distributions in the charge exchange reaction $K_1^0 p \rightarrow K^+ n$ are studied, the object being to search for Z* states in the K-N system. (UK)

3619 (DNPL/R-19, pp 63-83) EXPERIMENTAL PROGRAMME AT DESY. Lohrmann, E. (Deutsches Elektronen-Synchrotron, Hamburg). 1971.

From Proceedings of the Daresbury study weekend; Daresbury, England (1 Oct 1971).

Some parameters of the 7.5-GeV DESY electron synchrotron are first given, followed by details of high energy experiments with the ejected electron beam, photon-beam, and polarized photon beam. Details are also given of the proposed storage rings. (UK)

3620 (DNPL/R-19, pp 85-128) EXPERIMENTS ON ELECTRON-POSITRON COLLIDING BEAMS. Conversi, M. (Univ., Rome). 1971.

From Proceedings of the Daresbury study weekend; Daresbury, England (1 Oct 1971).

A list is first given of the e^+e^- storage rings in operation or under construction in the world. The effort required to produce these is rewarded by the wide new fields they have opened for study. They have made possible the direct investigation of processes that occur through the conversion of the e^+e^- system into a virtual photon of zero momentum and of mass equal to the total center-of-mass energy, that is, the energy $E_+ + E_- = 2E$ of the two colliding beams. The field of the extremely time-like photons thus becomes accessible to experiment; this is a field difficult to attack by more conventional methods. Nonstrange neutral vector mesons, such as ρ, ω, ϕ, which have the same quantum numbers as the photon can be produced singly, as resonant states observable through their decay products. These processes proceed to first order. A considerable amount of experimental work has been carried out at Orsay and Novosibirsk on these vector mesons, which in the well known model of "vector dominance" are the only hadrons directly coupled to the electromagnetic field. In general all important hadronic final states can be observed and measured. Coupling constants that are fundamental parameters of the vector dominance theory can be deduced in a direct way by e^+e^- storage ring experiments. Recent results are presented concerned with tests of quantum electrodynamics, vector mesons, high energy hadronic events, and the baryon structure in the time-like region. Prospects for future work are also discussed. 48 references. (UK)

3621 (LAL-RI-72-2) LOW TRANSFER COHERENT PHOTOPRODUCTION (220 TO 500 MeV) OF π^0 WITH DEUTERIUM. Grelaud, B. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). May 1972. 78p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The differential cross section of the $\gamma d \rightarrow \pi^0 d$ reaction at low transfer was studied in the energy region corresponding to the first π-N resonance. The measurements confirmed the existence of a definite structure quite near to the NN* production threshold, this structure being due to constructive interference of the photoproduction amplitudes with the neutron and the proton. The theoretical interpretation of the results was made in the framework of the impulse approximation using the unitarity properties of the scattering matrix and the dispersion relations. (France)

3622 (LNF-72/11) MULTIHADRONIC CROSS SECTIONS FROM e^+e^- ANNIHILATION AT C. M. ENERGIES BETWEEN 1.4 AND 2.4 GeV. Bacci, C.; Baldini-Celio, R.; Capon, G.; Mencuccini, C.; Murtas, G. P.; Penso, G.; Reale, A.; Salvini, G.; Stella, B. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 11 Feb 1972. 14p. Dep. NTIS (U. S. Sales Only).

Multihadronic production was observed at the Adone e^+e^- storage ring, in the c.m. energy range 1.4 to 2.4 GeV. The cross sections for the reactions $e^+ + e^- \rightarrow 2\pi^\pm + n\pi^0$ $(1 \leq n \leq 4)$ and $e^+ + e^- \rightarrow (4\pi^\pm + n\pi^0;\ 6\pi^\pm)$ $(0 \leq n \leq 2)$ were measured, assuming that the produced particles are only pions with a pure phase space momentum distribution. (auth)

3623 (LNF-72/71) MULTIHADRON PRODUCTION IN e^+e^- COLLISION AT HIGH ENERGY. Borgia, B.; Ceradini, F.; Conversi, M.; (and others) (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 2 Aug 1972. 62p. Dep. NTIS (U. S. Sales Only).

The cross sections for multipion production in $e^+ + e^-$ annihilation above 1.2 GeV in colliding beams are studied. The total cross section and the energy dependence of the partial cross sections are found. Also the possible production of a ρ' resonance in the $e^+ + e^- \rightarrow 2\pi^+ + 2\pi^-$ is discussed. The mass and width of this resonance are found. (J.F.P.)

3624 (NP-19470) COINCIDENCE EXPERIMENT ON π^+ ELECTROPRODUCTION NEAR THRESHOLD. Internal Note No. 383. Amaldi, E.; Beneventano, M.; Borgia, B.; de Notaristefani, F.; Frondaroli, A.; Pistilli, P.; Sestili, I.; Severi, M. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 16 Jun 1972. 39p. Dep. NTIS (U. S. Sales Only).

The cross section for electroproduction of π^+ at threshold, i.e., $\lim_{\theta^* \rightarrow 0} [1/9^* (d\sigma/dw_e dr_{02})]$ was measured for two values of the four-momentum $(-k^2 = 4F^{-2} = 0.16\ (GeV/c)^2$ and $6F^{-2} = 0.24\ (GeV/c)^2)$ by measuring the electrons scattered inelastically in coincidence with the neutrons produced in the reaction $e + p \rightarrow e' + n + \pi^+$. The experimental results of this as well as of a previous experiment $(at\ -k^2 = 5F^{-2} = 0.20\ (GeV/c)^2)$ are analyzed by two different methods in order to determine the isovector axial-form factor G_A of the nucleon. The results of the two analyses agree within the experimental error of about 10%. The isovector axial form factor is well represented by dipole expression with $M_a = (1.02 \pm 0.04)$ GeV. (auth)

3625 MEASUREMENT OF THE LOCAL PRODUCTION OF MUONS UNDERGROUND. Elbert, J. W.; Keuffel, J. W.; Thompson, Julia A. (Univ. of Utah, Salt Lake City). Phys. Rev. Lett.; 29: No. 18, 1270-4(30 Oct 1972).

The rate of stopping muons at a depth of 1.45×10^5 g/cm^2 was measured with a view to checking the anomalously high rate observed by Baschiera et al. at Mont Blanc. Muons produced locally could be separately identified with a large spark counter array. Their rate agrees with expectation based on muoproduction of hadronic cascades in the rock. The Mont Blanc result cannot be reconciled with this one if the excess stopping muons are produced by high-energy muons. (auth)

3626 COHERENT PHOTOPRODUCTION OF THE π^0 MESON FROM DEUTERIUM IN THE FIRST RESONANCE REGION. Bouquet, B.; Buon, J.; Grelaud, B.; (and others) (Paris Univ., Orsay, France). Phys. Lett.; 41B: No. 4, 536-8(16 Oct 1972).

The differential cross section of the reaction $\gamma D \rightarrow \pi^0 D$ was measured at constant momentum transfer for photon energy ranging from 220 MeV to 500 MeV. (auth)

3627 ELASTIC ELECTRON SCATTERING FROM ^{3}He AT HIGH MOMENTUM TRANSFER. Bernheim, M. (Ecole Normale Superieure, Orsay, France); Blum, D.; McGill, W.; (and others). Lett. Nuovo Cim.; 5: No. 5, 431-4(30 Sep 1972).

A measurement of the electron scattering cross section of ^{3}He at high values of the momentum transfer was performed in order to gain information on the form factors where the existing points have a low statistics and to extend the transverse form factor to higher q^2. (L.B.S.)

3628 EXPERIMENTS ON ELECTROPRODUCTION IN HIGH ENERGY PHYSICS. Heinloth, K. (DESY, Hamburg). Springer Tracts Mod. Phys.; 65: 92-145(1972).

A combined survey is given of the experimental information on inelastic electron scattering and exclusive reactions of the electroproduction of mesons. The viewpoints of models of nucleon structure and the photon–hadron coupling obtained are discussed. Also an understanding of the models and their limitations is discussed by comparing various experimental information. The essence of meson electroproduction, cross section formulas and radiative corrections, experimental data, and nucleon structure models for the total cross sections of virtual-photon absorption, experimental data and production dynamics models for differential cross sections of meson production with virtual photons, and a combined study of the experimental data and the corresponding models of total and differential cross sections of virtual-photon production processes are covered. (J.F.P.)

3629 ELECTROPRODUCTION OF PIONS ON NUCLEONS OF ^{6}Li NUCLEUS. Titov, Yu. I.; Stepula, E. V.; Afanas'ev, N. G.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 8, 1282-6(Aug 1972). (In Russian).

The results are presented of investigations of inelastic electron scattering by ^{6}Li nucleus at the initial energy of 1180 MeV in the angular range of 16 to 55°. Each spectrum was measured in the region of a quasi-elastic peak and Δ_{1236} isobar. The results are compared with calculation in the impulse approximation. (auth)

3630 MEASUREMENT OF THE ASYMMETRY PARAMETER IN THE PHOTOPRODUCTION OF φ MESONS. Halpern, H. J. (Univ. of Wisconsin, Madison); Prepost, R.; Tompkins, D. H.; (and others). Contract AT(11-1)1881. Phys. Rev. Lett.; 29: No. 20, 1425-7(13 Nov 1972).

The asymmetry parameter $\Sigma = (\sigma_{||} - \sigma_{\perp})/(\sigma_{||} - \sigma_{\perp})$ was measured for the photoproduction of φ mesons with photons polarized parallel and perpendicular to the plane of decay for the reaction $\gamma p \rightarrow \varphi p \rightarrow K^+K^-p$. The value $\Sigma = 0.985 \pm 0.12$ at a photon energy of 8.14 GeV and $|t|$ of 0.2 $(GeV/c)^2$, consistent with pure diffraction production, or pure natural-parity Regge exchange, was found. (auth)

3631 INCLUSIVE PROTON DISTRIBUTIONS IN ELECTROPRODUCTION. Lazarus, E. (Cornell Univ., Ithaca, N. Y.); Andrews, D.; Berkelmen, K.; (and others). Phys. Rev. Lett.; 29: No. 20, 1409-11(13 Nov 1972).

Measurements are reported for the process $e + p \rightarrow e + p + x^0$ at $Q^2 = 0.3$, 0.6, and 1.2 GeV^2 and for $0.875 \leq m_x^2 \leq 1.875$ GeV^2. Protons are produced predominantly backward in the center-of-mass frame, with average transverse momenta increasing with Q^2. (auth)

3632 STUDY OF CHARGED FINAL STATES PRODUCED IN e^+e^- INTERACTIONS. Alles Borelli, V.; Bernardini, M.; Bollini, D.; (and others) (CERN, Geneva). pp 790-809 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

The following reactions were studied at 800 to 875 MeV: $e^+e^- \rightarrow e^\pm e^\mp$, $e^+e^- \rightarrow \mu^\pm\mu^\mp$, $e^+e^- \rightarrow e^\pm\mu^\mp$, $e^+e^- \rightarrow e^\pm\mu^\mp$ + anything, $e^+e^- \rightarrow h^\pm h^\mp$, and $e^+e^- \rightarrow h^\pm h^\mp$ + anything. A preliminary analysis of the data yields production angular distributions and acollinearity distributions for various reactions. (L.B.S.)

3633 QUASI-ELASTIC ELECTRON SCATTERING BY ^{11}B, ^{12}C, ^{27}Al, ^{39}K, AND ^{40}Ca NUCLEI AT LARGE MOMENTUM TRANSFERS. Vlasenko, V. G.; Afanas'ev, N. G.; Goldshtein, V. A.; (and others) (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 9, 1540-5(Sep 1972). (In Russian).

The results of an experimental study of the quasi-elastic 550- to 1150-MeV electron scattering by ^{11}B, ^{12}C, ^{27}Al, ^{39}K and ^{40}Ca nuclei are presented. The integrated $[d\sigma(E_0,\theta)/d\Omega]$ cross sections in the quasi-elastic scattering region are compared with the values obtained in terms of the shell and Fermi gas nuclear models. (auth)

3634 INCLUSIVE π^+ ELECTROPRODUCTION AND THE HYPOTHESIS OF LIMITING FRAGMENTATION. Rai Choudhury, S. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 5: No. 7, 535-6(14 Oct 1972).

The measurements for $e + p \rightarrow e + \pi^+ +$ anything interactions are related by factorization to other hadronic inclusive cross sections. The invariant structure function for inclusive π^+ electroproduction is computed, and it is found that the electroproduction data are consistent with the hypotheses of limiting fragmentation and factorization. (J.F.P.)

3635 ELECTRON–POSITRON INTERACTIONS AT HIGH ENERGIES. Bartoli, B. (Comitato Nazionale per l'Energia Nucleare, Frascati, Italy); Felicetti, F.; Ogren, H.; (and others). Phys. Rev., D; 6: No. 9, 2374-2404(1 Nov 1972).

The results of an experiment performed at Adone, the 2×1.5-GeV e^+e^- Frascati storage ring, are presented. During ~ 1500 hours of running time a total of 5164 electron-positron elastic scattering events (integrated luminosity $L = 3.5 \times 10^{35}$ cm^{-2}) and 605 noncoplanar events from the reaction $e^+e^- \rightarrow a^\pm + b^\pm +$ anything (effective integrated luminosity $L = 2.5 \times 10^{35}$ cm^{-2}) have been collected at cm energies ranging from 1.4 to 2.4 GeV. Over the energy range explored (1.4–2.4 GeV), corresponding to an average q^2 ranging from 0.8 to 2.4 $(GeV/c)^2$, the yield of wide-angle ($60° < \theta < 120°$) electron-positron elastic scattering events is found to be in good agreement with the predictions of quantum electrodynamics (QED) ($R = \sigma_{exp}/\sigma_{QED} = 1.05 \pm 0.04$). The noncoplanar events appear to be of a hadronic nature and are produced with a much higher cross section than predicted on the basis of ρ, ω, ϕ dominance at these energies. The total cross section for the reaction $e^+e^- \rightarrow a^\pm b^\pm +$ anything shows a rapid increase to ~90 nb between 1.0 and 1.5 GeV and falls off slowly to ~50 nb at 2.4 GeV. Cross sections for some of the channels contributing to this multihadron process ($e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$, $e^+e^- \rightarrow \pi^+\pi^-\pi^+\pi^-$ + neutrals, $e^+e^- \rightarrow 3\pi^+3\pi^-$) have been determined and are reported. (auth)

3636 MEASUREMENT OF PION–PROTON BREMSSTRAHLUNG AND A SEARCH FOR MAGNETIC DIPOLE MOMENT RADIATION FROM THE Δ^{++} (1236). Arman, M. Los Angeles; Univ. of California (1972). 126p. University Microfilms Order No. 72-25,748.

Thesis.

The reaction $\pi^+ + p \rightarrow \pi^+ + p + \gamma$ was measured at the LRL 184" cyclotron using incident pions of 295 MeV. The trajectory and the momentum of the forward going pions, $\theta_{Lab}(\pi) = -51 \pm 6°$, were determined with a large picture frame magnet, wire spark chambers and counters. The trajectory and the energy of the forward going protons, $\theta_{Lab}(P) = 40 \pm 23°$, were determined with wire spark chambers and six range counters. Photons in the backward direction, $\theta_{Lab}(\gamma) = 140 \pm 20°$, were detected in ten lead glass Cerenkov counters. The geometry was chosen such that the magnetic dipole moment of the Δ^{++} is expected to give a substantial contribution to the π^+p bremsstrahlung cross section. The shape of the photon spectrum observed is substantially different from that of the predicted spectra, and the measured cross section at $E\gamma = 100$ MeV is a factor of ten lower than the prediction based on the isobar model. Also $\pi^- + p \rightarrow \pi^- + p + \gamma$ was measured with the same setup. The results of this measurement are in reasonable agreement with the prediction based on the "soft photon theorem" of Low. (Diss. Abstr. Int., B)

3637 PHOTOPRODUCTION OF NEUTRAL RHO MESONS FROM HYDROGEN. Walstrom, P. L. Ithaca, N. Y.; Cornell Univ. (1972). 115p. University Microfilms Order No. 72-27,989.

Thesis.

Detailed dipion mass distributions over the rho resonance region in $\pi^+\pi^-$ pair photoproduction from hydrogen were measured at an average dipion energy of 8.5 GeV, out to a t-value of −0.5 GeV^2. The pion pair was detected by a magnetic pair spectrometer, which was tilted in a vertical plane in order to vary the dipion production angle. The inelastic contribution to the pion pair cross section was eliminated for t-values from −0.08 to −0.5 GeV^2 by requiring a recoil proton in coincidence with the pion pair detected by the pair spectrometer. The recoil proton was detected by a scintillation counter hodoscope. The overall inelastic fraction is found by extrapolation from higher t-values to be (0.0 ± 0.05) at 0°, and increases to (0.25 ± 0.05) at $t = -0.5$ GeV^2. Detailed mass-fits were made to the data using a Söding interference model, in order to obtain the "elastic" ρ^0 and Drell contributions. The behavior of the dipion mass distribution with t is found to be well described by the Söding model, including the skewing towards loss masses and the reduced skewing at large t. Both the magnitude and relative t-dependence of the Drell term are in good agreement with theoretical predictions. (Diss. Abstr. Int., B)

Weak

Refer also to abstracts 3752 and 3872.

3638 (DNPL/R–19, pp 177-97) NEUTRINO PROGRAMME AT CERN I. Cundy, D. C. (CERN, Geneva). 1971.

From Proceedings of the Daresbury study weekend; Daresbury, England (1 Oct 1971).

It is stated that high energy neutrino physics at present provides the only way of investigating the weak interaction at energies and four-momentum transfers higher than those observed in the weak decay of elementary particles. Owing to the small interaction probability of the neutrino, however, neutrino physics is very costly in terms of machine time and detectors. This, combined with the fact that other accelerators are running neutrino physics programs, or planning to do so, makes a decision on the type of program for CERN I difficult. Consideration is given to both the physics ques-

tions to be investigated and the neutrino facilities available. A list of some of the interesting problems is given that concern lepton currents and hadronic currents. It was decided that the CERN I neutrino program will be limited to heavy liquid experiments. Physics questions that can be investigated in the Gargamelle bubble chamber are discussed; these are concerned with elastic hyperon production, neutral current processes, diagonal interactions, lepton numbers, heavy leptons and deep inelastic scattering. 12 references. (UK)

3639 (FRNC-TH-249) STUDY OF THE $K^0 \rightarrow \pi^+\pi^-\pi^0$. Aubert, Jean-Jacques (Paris Univ., Orsay (France)). 1972. 119p. (In France). Dep. NTIS (U. S. Sales Only).

The studies undertaken led to a four-fold improvement in the accuracy of preceding experiments. The η_{+-0} parameter was obtained by measuring the PC violation in the $K^0 \rightarrow \pi^+\pi^-\pi^0$ decay. Theoretical predictions of current algebra models are compared with measured values. Disobedience of the $\Delta I = 1/2$ rule does not appear to be explainable on the assumption of a magnetic origin of the $\Delta I = 3/2$ transition. In contrast, the current algebra model with $\Delta I \leq 3/2$, electromagnetic corrections, and corrections due to interactions in the final state correctly reproduces the experimental results. (France)

3640 (UCI-10-P-19-74) RESEARCH PROGRAM IN NEUTRINO PHYSICS, COSMIC RAYS, AND ELEMENTARY PARTICLES. Progress Report, 1 October 1971–30 September 1972. Reines, Frederick (California Univ., Irvine). Sep 1972. Contract AT(11-1)-Gen-10. 65p. Dep. NTIS.

A summary of research is given mainly on neutrinos in reactors and cosmic rays and cosmic muons. (J.F.P.)

3641 (UCI-10-P-19-X-1) RESEARCH PROGRAM IN NEUTRINO PHYSICS, COSMIC RAYS, AND ELEMENTARY PARTICLES. Progress Report, October 1, 1970–September 30, 1971. Reines, F. (California Univ., Irvine). Aug 1971. Contract AT-11-1-GEN-10. 63p. Dep. NTIS.

A summary of research on neutrinos in reactors and cosmic rays and cosmic muons is given. (J.F.P.)

3642 MEASUREMENT OF BRANCHING RATIO FOR $K^+ \rightarrow e^+\nu$. Clark, A. R.; Cork, Bruce; Elioff, T.; Kerth, L. T.; (and others) (Univ. of California, Berkeley). Phys. Rev. Lett.; 29: No. 18, 1274-7(30 Oct 1972).

By using a 2π-sr magnetic spectrometer, the branching ratio for $K^+ \rightarrow e^+\nu$ relative to that for $K^+ \rightarrow \mu^+\nu$ was measured to be $(2.42 \pm 0.42) \times 10^{-5}$, in good agreement with the predictions of the V–A theory. (auth)

3643 MEASUREMENT OF THE CHARGE ASYMMETRY IN THE DECAY $K_L^0 \rightarrow \pi^\pm\mu^\mp\nu$. Piccioni, R.; Coombes, R.; Donaldson, G.; (and others). (Stanford Univ., Calif.). Phys. Rev. Lett.; 29: No No. 20, 1412-15(13 Nov 1972).

The charge asymmetry in the decay $K_L^0 \rightarrow \pi^\pm\mu^\mp\nu$ was measured to be $(2.78 \pm 0.51) \times 10^{-3}$, leading to a value of $\mathrm{Re}\epsilon$ in good agreement with the results from the $K_L^0 \rightarrow 2\pi$ decay modes. (auth)

3644 MULTIPLE SCATTERING OF COSMIC RAY MUONS IN THE RANGE 10 TO 70 GeV/c. Ayre, C. A.; Hamdan, M. A.; Hume, C. J.; (and others) (Univ. of Durham, Eng.). J. Phys., A (London); 5: No. 10, L102-5(Oct 1972).

The new Durham spectrograph, MARS, was used to study the Coulomb scattering of cosmic ray muons in iron in the momentum range 10 to 70 GeV/c. The observed root mean square lateral displacement agrees well with that predicted to within the statistical errors, which range from 2% at the lowest momentum to 17% at the highest momentum. Averaged over the whole momentum range the ratio of observed to expected root mean square scattering displacement is 1.023 ± 0.019. (auth)

3645 DECAY $\Sigma^\pm \rightarrow \Lambda e^\pm\nu$. Franzini, P. (Columbia Univ., New York); Newman, R.; Eisele, F.; (and others). Phys. Rev., D; 6: No. 9, 2417-23(1 Nov 1972).

The ratio of the vector to axial-vector coupling constant for $\Sigma^\pm \rightarrow \Lambda e^\pm\nu$ decays using 186 events is determined to be -0.37 ± 0.20. The branching ratio for $\Sigma^- \rightarrow \Lambda e^-\nu$ is $(0.62 \pm 0.07) \times 10^{-4}$ and for $\Sigma^+ \rightarrow \Lambda e^+\nu$ is $(0.21 \pm 0.05) \times 10^{-4}$. An upper limit on the magnitude of the ratio of the axial-magnetism to axial-vector coupling constants is 3.2. (auth)

Strong (Baryon-induced)

Refer also to abstract 4009.

3646 (CEA-CONF-2036) PRELIMINARY DETERMINATION OF THE AVERAGE CHARGED PARTICLE MULTIPLICITY AND OF THE TOPOLOGICAL CROSS SECTIONS IN 50-GeV/c AND 69-GeV/c PP INTERACTIONS. (Commissariat a l'Energie Atomique, Paris (France)). 1971. 6p. (CONF-720419-4). Dep. NTIS (U. S. Sales Only).

From fourth international conference on high energy collisions; Oxford, England (5 Apr 1972).

The interactions of 50- and 69-GeV/c protons in a hydrogen bubble chamber were studied. The topological cross sections, mean charged-particle multiplicity, and the dispersion are found. (J.F.P.)

3647 (COO-1545-118) Λ AND NUCLEON RESONANCE PRODUCTION IN pp COLLISIONS AT 6 GeV/c. Knasel, T. M.; Swallow, E. C.; Winston, R. (Chicago Univ., Ill.); Romanowski, T. (Ohio State Univ., Columbus. Argonne National Lab., Ill.); Lesnik, A.; Meyer, T.; Rust, D.; Ward, C.; Yovanovitch, D. D. (Argonne National Lab., Ill.); Schwartz, D. M.; Stevens, A. J. (Ohio State Univ., Columbus). [nd]. 5p. (CONF-720923-6). Dep. NTIS.

From sixteenth international conference on high energy physics; Chicago, IL. (6 Sep 1972).

A study of proton reactions with targets at 6 GeV/c was made using a wire spark chamber spectrometer. The Λ production and width were found. Also $\Delta^{++}(1236)$ and $\Delta^0(1236)$ were produced. (J.F.P.)

3648 (COO-1545-119) MEASUREMENT OF THE UP-DOWN ASYMMETRIES IN THE BETA DECAY OF POLARIZED LAMBDA HYPERONS. Lindquist, J.; Sumner, R. L.; Swallow, E. C.; Winston, R.; Wolfe, D. M. (Chicago Univ., Ill.); Phillips, P. R. (Washington Univ., St. Louis, Mo.); Reibel, K.; Schwartz, D. M.; Stevens, A. J. (Ohio State Univ., Columbus); Romanowski, T. A. (Argonne National Lab., Ill. (Ohio State Univ., Columbus); Watson, J. M. (Argonne National Lab., Ill.). 1972. 15p. (CONF-720923-8). Dep. NTIS.

From 16th international conference on high energy physics; Chicago, IL. (6 Sep 1972).

An optical spark chamber spectrometer was used to determine the branching ratio and up-down asymmetry parameters for $\Lambda \rightarrow p + e + \nu$ decay. (auth)

3649 (LPNHE-72/3) REVIEW OF THE EXPERIMENTAL DISTRIBUTIONS OF INCLUSIVE REACTIONS. Boratav, M.; Nguyen Huu Khanh (Paris Univ. (France). Laboratoire de Physique Nucleaire et de Hautes Energies). 15 Mar 1972. 88p. (In French). Dep. NTIS (U. S. Sales Only).

A large number of experimental distributions of inclusive reactions are presented. The definitions and properties of the usual variables and the distribution and correlation functions are reviewed. The principal experiments used to study inclusive reactions are presented. A general description of the characteristics of the distributions is given for each variable together with a discussion on its correlation with other variables. In general, inclusive spectra have very simple forms and can be represented by exponential functions; the distributions are not very dependent on the incident energy. The exact verification of the scale invariance hypothesis or the limited fragmentation hypothesis appears to be difficult. The experimental results currently available demonstrate that the limited fragmentation hypothesis is valid for values less than 10 GeV/c and that the scale invariance hypothesis is not valid in the central region. (France)

3650 CHARGED PARTICLE PRODUCTIONS AT 90^0 IN THE CENTER OF MASS IN VERY HIGH ENERGY PROTON–PROTON COLLISIONS. Banner, M. (CEN, Saclay, France); Hamel, J. L.; Pansart, J. P.; (and others). Phys. Lett.; 41B: No. 4, 547-51 (16 Oct 1972).

The transverse momentum distribution at 90° of pions, protons, and antiprotons was measured at the CERN intersecting storage rings for C.M. energies between 23.2 and 52.7 GeV. In this energy range, the pion and proton distributions are almost energy independent. The antiproton production rises by a factor of two between 23.2 and 52.7 GeV. (auth)

3651 ISOSPIN ANALYSIS OF EXCHANGE MECHANISMS AND (ΣK) SYSTEMS IN $NN \rightarrow (\Sigma K)N$ AT 6 GeV/c. Charlesworth, J. A.; Intizar, N.; Neale, W. W.; Rushbrooke, J. G. (Cavendish Lab., Cambridge, Eng.). Nucl. Phys., B48: No. 1, 225-36(1972).

Using new data on the reactions $np \rightarrow \Sigma^-K^+p$ and $np \rightarrow \Sigma^0K^0p$ a total of seven independent charge channels for the basic reaction $NN \rightarrow (\Sigma K)N$ was investigated to obtain a constrained solution for the three isospin amplitudes and their relative phases at 6 GeV/c. The amplitude for production of an $I = 3/2$ (ΣK) system by isovector exchange is the largest, the associated (ΣK) mass distribution showing evidence for Δ(1950) production. Both the $I = 1/2$ and $I = 3/2$ (ΣK) mass distributions produced by isovector exchange agree qualitatively with one-pion exchange predictions using experimen-

tal $\pi N \rightarrow \Sigma K$ cross sections. Isoscalar exchange accounts for only about 20% of the total reaction amplitude. (auth)

3652 EVIDENCE FOR TWO-CLUSTER FORMATION IN ONE-, TWO-, THREE-, AND FOUR-PION PRODUCTION 28 GeV/c p–p AND p–d COLLISIONS. Burdett, W. (Vanderbilt Univ., Nashville); Hanlon, J.; Panvini, R. S.; (and others). Nucl. Phys., B48: No. 1, 13-28(1972).

The reactions $pd \rightarrow (p_S)\ pp\pi^-$, $pp \rightarrow pp\pi^+\pi^-$, $pd \rightarrow (p_S)\ pp\pi^-\pi^-\pi^+$ and $pp \rightarrow pp\pi^+\pi^-\pi^+\pi^-$ at approximately 28 GeV/c were studied, as examples of one, two, three- and four-pion production, respectively. One-pion production occurs mainly as the fragmentation or excitation of the target neutron into a low-mass ($p\pi^-$) cluster. Likewise, the two-pion production is seen to be mainly the production of a low-mass ($p\pi^+\pi^-$) cluster recoiling opposite the remaining proton. For three- and four-pion production, clustering of particles is much less obvious; nevertheless, the data may be interpreted as showing that single excitation is still the dominant process as in the Nova model of Jacob and Slansky. The technique for examining cluster production involves examining the distribution of rapidities of final-state particles. However, it must be realized that the reactions studied represent only the lowest multiplicities at 28 GeV/c and that particle production in general at this momentum cannot be assumed to be represented by the low-multiplicity channels studied here. The production of secondaries as a result of cluster formation is an attractive model but the analysis shows that, except for the lowest multiplicities, it is certainly not a unique description of the data. (auth)

3653 FURTHER STUDY OF THE ANOMALOUS BEHAVIOR OF SECONDARY PARTICLES EMITTED FROM HEAVY PRIMARY INTERACTIONS. Judek, B. (National Research Council, Ottawa). Can. J. Phys.; 50: No. 18, 2082-95(15 Sep 1972).

Interaction lengths of singly charged relativistic secondary particles emitted from interactions of very heavy cosmic ray nuclei in emulsions were measured by systematic following of their tracks through the stack. The primary energies were determined by the "knock on" electron method. The results show that particles from interactions with primary energies between 1 and 5 GeV/nucleon emitted in the angular interval $1 < \theta/\theta_{ev} \leq 4$ (θ_{ev} is the expected RMS angle for evaporation protons) have significantly shorter mean free paths. The variation of the observed mean free paths with distance from the primary interactions shows a transition from short to normal interaction lengths at about 3 cm which indicates the presence of some anomalous component interacting with a very short mean free path of a few cm and relative intensity of order of 10%. This result cannot be accounted for by any known particle or interaction. Considerations of emission angles and types of stars produced by the secondary particles lead to a tentative conclusion that particles exhibiting the anomalously short interaction lengths are scattered fragments of the incident nuclei. (auth)

3654 STUDY OF 14 GeV PROTON–NUCLEON NUCLEAR INTERACTIONS IN A NUCLEAR EMULSION. Singh, Virk Hardev (Univ., Paris). Compt. Rend., Ser. B; 275: No. 5, 219-22(31 Jul 1972). (In French).

The complete identification of the particles emitted from white stars led to the study of different nuclear reaction parameters such as the angular distribution and the transverse momenta distribution in the center of mass system. The results for the value of the transverse momentum are in good agreement with those obtained using the Hagedorn model. (France)

3655 DISINTEGRATIONS AND INTERACTIONS OF SIGMA HYPERONS IN NUCLEAR EMULSION. Simonovic, J. Belgrade; Faculty of Natural Sciences and Mathematics (1970). (In Serbo-Croatian).

Thesis.

A survey of past work on the investigations into the nature and interaction of sigma hyperons is given. The results of studies of every angle of interaction of K^- mesons with protons from the nuclei of emulsions are given. From voluminous experimental material, irrespective of the nucleus, cases of production of only two particles which were sigma hyperons and π mesons were investigated. From the obtained material the characteristics of sigma hyperons were investigated. The relation between the various kinds of disintegrations of ϵ^- hyperons, the relation of production of ϵ^- to ϵ^+ hyperon, participation of Auger's effect for absorption of K^- mesons and ϵ^- hyperons on heavy and light atoms as well as data on their absorption was established. For nuclear absorption of ϵ^- hyperones the relative yields with the specifics of the process were established. For individual processes the energy spectrum of the products of interaction was also given. Besides the process of absorption according to the kind of emulsion nuclei is established. Investigations into the absorption of K^- mesons on light and heavy nuclei of emulsion showed that the effect of a slow K^- meson on the proton is more frequent than on the heavy nucleus. The results of these data are confirmed, but they also suggest that for absorption of hyperons the process is obverse. This unexpected result annihilates the earlier conclusions on the interaction and calls for a complement of present notions on the mechanism of the reaction. (Bull. Sci. Sect A Sci. Nat. Tech. and Med.)

3656 INCLUSIVE FEATURES OF π^+ SPECTRA IN COHERENT $\bar{p}d$ INTERACTIONS AT 5.55 GeV/c. Braun, H.; Fridman, A.; Gerber, J. P.; (and others) (CRN, Strasbourg) Phys. Rev., D; 6: No. 9, 2311-21(1 Nov 1972).

An analysis is presented of the coherently produced single and double inclusive $\bar{p}d \rightarrow \pi^+X$ and $\bar{p}d \rightarrow \pi^+dX$ processes obtained from a 150,000-photograph $\bar{p}d$ exposure at 5.55 GeV/c. Here X, which denotes anything, contains for the $\bar{p}d \rightarrow \pi^+X$ reaction at least a deuteron or its dissociated pn state produced by a final-state interaction. A representative sample of events was obtained by using only fitted channels. A good parametrization of the single inclusive process is obtained using a thermodynamical-type function. A comparison of the data with other inclusive processes is carried out. As only fitted channels are used for the present analysis, a prominent d* enhancement could be observed in the final state. The presence of this enhancement is used to define a short-range correlation length in the rapidity space for the $\bar{p}d \rightarrow \pi^+X$ and $\bar{p}d \rightarrow \pi^+dX$ reactions. For the $\bar{p}d \rightarrow \pi^+dX$ process some correlation parameters between the outgoing π^+ and d are defined, and these parameters are compared with peripheral phase-space predictions. (auth)

3657 COMPARISON OF THE REACTIONS $pp \rightarrow \pi^{\pm}$ + ANYTHING AT 28.5 GeV/c AND AT ~1000 GeV/c, AND COMMENTS ON SCALING. Hanlon, J. (Vanderbilt Univ., Nashville); Panvini, R. S.; Salant, E. O.; Sims, W. H.; Morris, T. W. Phys. Rev., D; 6: No. 9, 2698-2700(1 Nov 1972).

28.5-GeV/c bubble-chamber data are compared with recent CERN Intersecting Storage Rings counter data on the reactions $pp \rightarrow \pi^{\pm}$ + anything and it is concluded that the scaling limit, in the sense of energy dependence, has not been reached at 28.5 GeV/c for small values of transverse pion momentum. (auth)

3658 ENERGY DEPENDENCE OF BACKWARD ELASTIC SCATTERING OF PROTONS WITH DEUTERONS FOR ENERGY RANGE 360 TO 670 MeV. Komarov, V. I.; Kosarev, G. E.; Reshetnikov, G. P.; Savchenko, O. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 16: No. 2, 234-41 (Aug 1972). (In Russian).

The energy dependence of proton–deuteron elastic scattering at 168° in the c.m.s. in the energy range of incident protons 360 to 670 MeV was measured. The data analysis points to a considerable contribution to backward pd-scattering at 400 to 700 MeV of scattering mechanism, caused by virtual process $p + N \rightarrow d + \pi$ on one of the deuteron nucleons. (auth)

Strong (Meson-induced)

Refer also to abstracts 3784 and 3820.

3659 (CEA-CONF-2037) QUASI TWO BODY AND TWO BODY INELASTIC HADRONIC INTERACTIONS. Barloutaud, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1972. 48p. (CONF-720419–5). Dep. NTIS (U. S. Sales Only).

From 4th international conference on high energy collisions; Oxford, England (5 Apr 1972).

A review is given of new high energy results on two-body inelastic and quasi-two-body reactions where a well established and identified meson or baryon resonance is produced to determine whether the diffractive mechanism is completely forbidden. Also some recent results of diffraction dissociation are reviewed determining whether diffraction dissociation reactions are quasi-two-body reactions. Finally, the possible existence of other quasi-two-body processes involving narrow high mass mesonic resonances from boson missing-mass spectrometer data is reviewed. (J.F.P.)

3660 (COO–1545-120) STUDY OF THE REACTION $\pi^-p \rightarrow \Lambda K^0$ AT ΣK THRESHOLD. Knasel, T. M.; Lindquist, J.; Nelson, B.; Sumner, R. L.; Swallow, E. C.; Winston, R. (Chicago Univ., Ill.); Romanowski, T. A. (Ohio State Univ., Columbus. Argonne National Lab., Ill.); Watson, J. M. (Argonne National Lab., Ill.); Schwartz, D. M.; Stevens, A. J. (Ohio State Univ., Columbus). 1971. 13p. (CONF-720923–7). Dep. NTIS.

From sixteenth international conference on high energy physics; Chicago, IL. (6 Sep 1972).

The total and differential cross sections for $\pi^- + p \rightarrow \Lambda + K^0$ interactions at 930 to 1130 MeV/c were measured. Polarization angular distributions are also shown. (J.F.P.)

3661 HIGH TRANSVERSE MOMENTUM AND BARYON EXCHANGE. Athens-Democritus-Liverpool-Vienna Collaboration. Phys. Lett.; 41B: No. 4, 539-41(16 Oct 1972).

Data are presented on the average transverse momentum of pions produced in events selected so as to enhance the baryon exchange contribution. High values are found compared with unselected events having only a small baryon exchange contribution. (auth)

3662 RESULTS ON $\pi\pi$-INTERACTION IN THE REACTION $\pi^-p \to \pi^0\pi^0n$ AT 8 GeV/c. Apel, W. D. (Univ., Karlsruhe, Ger.); Auslaender, J. S.; Mueller, H.; (and others). Phys. Lett.; 41B: No. 4, 542-6(16 Oct 1972).

Published $\pi\pi$-phase shifts are compared with results from an analysis of the reaction $\pi^-p \to \pi^0\pi^0n$. The "up"-solution as well as the "in-between"-solution for the I = 0 s-wave $\pi\pi$-scattering are ruled out. The only set of s-wave phase shifts consistent with our data is the "up-down"-solution with a rapid rise of δ_0^0 near the $K\bar{K}$-threshold. (auth)

3663 ANALYSIS OF THE $K^+\pi^+\pi^-$ SYSTEM PRODUCED IN 10 GeV/c K^+ COHERENT INTERACTIONS ON NUCLEI. Haatuft, A. (Univ., Bergen); Halsteinslid, A.; Myklebost, K.; (and others). Nucl. Phys., B48: No. 1, 78-94(1972).

The coherent production process K^+-nucleus $\to K^+\pi^+\pi^-$-nucleus was analyzed at 10 GeV/c, in a heavy liquid bubble chamber. Evidence for a coherent process is obtained from the momentum transfer distribution; the cross section is 2.12 ± 0.36 mb per nucleus. The $K^+\pi^+\pi^-$ mass distribution of the coherent events shows abundant production of the so-called Q^+ state, with a cross section of 1.70 ± 0.30 mb per nucleus. A Dalitz plot analysis of the $K^+\pi^+\pi^-$ system indicates $J^P = 1^+$ for the Q^+ with a high probability. The predominant decay is $K^*\pi$ with some contribution of $K\rho$. The density matrix elements for Q^+-production were studied. (auth)

3664 DETERMINATION OF THE MASSES OF THE CHARGED Σ HYPERONS. Bohm, G. (Deutsche Akademie der Wissenschaftne, Berlin); Krecker, U.; Wysotzki, F.; Adamovic, O.; (and others). Nucl. Phys., B48: No. 1, 1-12(1972).

The masses of the charged Σ hyperons were determined from the mean ranges of particles from the interactions of K^- mesons at rest on hydrogen in emulsion, $K^- + p \to \Sigma^\pm + \pi^\mp$, and also the mean range of the protons from $\Sigma^+ \to p + \pi^0$. The results are $m_{\Sigma^+} = 1189.39 \pm 0.06$ MeV/c^2, $m_{\Sigma^-} - m_{\Sigma^+} = 7.91 \pm 0.23$ MeV/c^2, which give $m_{\Sigma^-} = 1197.30 \pm 0.24$ MeV/c^2. The finding that the energy loss rate of low velocity negative particles is less than that of positive particles was confirmed, but in contradiction with an earlier result, the range straggling for negative particles was not found to be anomalously high. (auth)

3665 COMPARISON OF PARTICLE–ANTIPARTICLE ELASTIC SCATTERING FROM 3 TO 6 GeV/c. Ambats, I.; Ayres, D. S.; Diebold, R.; (and others) (Argonne National Lab., Ill.). Phys. Rev. Lett.; 29: No. 20, 1415-19(13 Nov 1972).

Differential cross sections for $\pi^\pm p$, $K^\pm p$, pp, and $\bar{p}p$ elastic scattering were measured at 3, 3.65, 5, and 6 GeV/c for momentum transfers from 0.03 to 1.5 GeV^2 using the Argonne effective mass spectrometer. Particular attention was paid to the relative particle-antiparticle normalization. The crossover points are consistent with no energy dependence, average values being 0.14 ± 0.03, 0.190 ± 0.005, and 0.160 ± 0.007 GeV^2 for π's, K's, and protons, respectively. (auth)

3666 REVIEW OF EXPERIMENTAL RESULTS ON THE $\pi\pi$ AND $K\pi$ INTERACTIONS. Schlein, P. E. (Univ. of California, Los Angeles). pp 648-767 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

The experimental situation regarding the $\pi\pi$ and $K\pi$ interactions is discussed, insofar as such information is obtained from peripheral di-boson production experiments. Constraints in partial wave analysis of on-mass-shell spinless particle scattering are first discussed. Procedures for extrapolation to the pion exchange pole are then discussed. The remaining topics deal with πp interaction studies in pp experiments, $\pi\pi$ elastic, inelastic, and charge exchange scattering in πp experiments, $K\pi$ interaction in Kp experiments, and off-shell effects in $p\pi^+$ and $\pi^-\pi^+$ elastic scattering near threshold. (L.B.S.)

3667 SEARCH FOR γ PRODUCTION FROM $\bar{K}^0p$ INTERACTIONS. Meisner, G. W. (Univ. of North Carolina, Greensboro). Nuovo Cim.; 12A: No. 1, 62-70(1 Nov 1972).

A secondary $\bar{K}^0$ beam from associated production from 1030- and 1170-MeV/c π^- in the Alvarez 72-inch hydrogen bubble chamber is used to observe three-body production $\bar{K}^0p \to Y\pi^+x^0$. All events are unambiguously identified; one final state is $\Lambda\pi^+\gamma$. This event and five others satisfying $\Lambda\pi^+\pi^0$ in the final state are consistent with $Y_1^*(1385)$ production. If this hypothesis is accepted, the branching ratio $\Gamma[Y_1^*(1385) \to \Lambda\gamma]/\Gamma[Y_1^*(1385) \to \text{all}] = 0.17 \pm 0.17$. (auth)

3668 MEASUREMENT OF THE BRANCHING RATIOS FOR ω NEUTRAL DECAYS. Dakin, J. T.; Hauser, M. G.; Kreisler, M. N.; Mischke, R. E. (Princeton Univ., N. J.). Phys. Rev., D; 6: No. 9, 2321-35(1 Nov 1972).

The neutral decay modes of the ω meson (784 MeV) were investigated by studying the energy spectrum of γ's from ω decays. The ω mesons were produced in the reaction $\pi^-p \to \omega n$. In each event the momentum of a single γ from the ω decay was measured in a pair spectrometer. The energy spectrum of γ's in the ω c.m. system (400 events after back-ground subtraction) was compared with spectra for various ω decay modes generated by a Monte Carlo program. The principal ω neutral decay, $\omega \to \pi^0\gamma$, was observed. The upper limit for the decay $\omega \to \eta\gamma$ was $(\omega \to \eta\gamma)/(\omega \to \text{neutrals}) < 36\%$ (90% confidence limit). The best fit to the γ spectrum was obtained by including a multibody decay, probably $\omega \to \pi^0\pi^0\gamma$ with $(\omega \to \pi^0\pi^0\gamma)/(\omega \to \text{neutrals}) = (22 \pm 7)\%$. (auth)

3669 INELASTIC K^+p REACTIONS AT INCIDENT MOMENTA FROM 1.37 TO 2.17 GeV/c. Loken, S. C. (California Inst. of Tech., Pasadena); Barish, B. C.; Gomez, R.; (and others). Phys. Rev., D; 6: No. 9, 2346-61(1 Nov 1972).

Inelastic K^+p reactions were studied in a 400,000-picture exposure of the LRL 25-in. hydrogen bubble chamber. Cross sections were obtained for single-pion and two-pion final states corresponding to the two-prong-V and four-prong topologies. These channels show a smooth energy dependence, consistent with observations at other momenta. The production and decay angular distributions for the quasi-two-body channels agree with the predictions of simple exchange models and show no evidence of an s-channel resonance. It is not possible, however, to place any quantitative limit on the production of a Z*. Quark-model relations for double-resonance production have been tested and are well satisfied by our data. (auth)

3670 PRODUCTION OF STRANGENESS-ONE BOSONS IN THE MASS INTERVAL 1200 TO 1600 MeV. Frati, W. (Univ. of Pennsylvania, Philadelphia); Halpern, J.; Hargis, P.; (and others). Phys. Rev., D; 6: No. 9, 2361-73(1 Nov 1972).

The production of S = 1 bosons in the mass interval 1200 to 1600 MeV was investigated in 4-GeV/c $\pi p \to \Lambda + X^0$ reactions using the missing-mass technique. The momentum and direction of the Λ was determined from the observation of its decay proton and pion in wire spark chambers and the measurement of the proton energy in a range telescope. The K*(1420) is studied along with a 4-standard-deviation peak at a mass of 1368 MeV. (auth)

3671 FRAGMENTATION OF Ag AND Br NUCLEI PRODUCED BY K-MESONS AT 1.5 GeV/c. Popov, S. Belgrade; Faculty of Natural Sciences and Mathematics (1970). (In Serbo-Croatian).

Thesis.

Fragments and hyperfragments are investigated. The basic theories of the emission of particles in nuclear reactions produced by particles of high energies, with special reference to the emission of fragments, i.e., charged particles Z > 2 are presented. For the studies on the fragmentation nuclear emulsions were used which at the same time served as a target and a detector, while for the determination of fragment charge the technique of measuring the width of the trace was used, and it was possible to establish errors of determination under individual conditions. A criterion of establishing reactions produced on light and heavy nuclei of the emulsion was established. The working method was first applied for investigation of the characteristic fragments B_5^8 and Li_3^8, the so-called hammer fragments. The frequency of the emission of hammer fragments, their energetic distribution and angular anisotropy were found. The results achieved were compared with the distribution called for by the theory of evaporation. Besides, the star of deterioration from which was emitted the hammer fragment was analyzed, and the excitation energy of the nucleus of the remainder was established. A similar procedure was applied for the analysis of fragments and hyperfragments. The basic results are as follows: The relative frequencies of emission of the fragments Z ≥ 3 in interactions K–meson from 1.5 GeV/c with nuclei Ag and Br of the nuclear emulsion were determined. The relative frequencies of various types of hammer fragments in relation to the total number of hammers were established. The experimental results of the energy distribution and angular anisotropy of fragments compared with the theoretical results for the process of evaporation show that the phenomenon of fragmentation may in the main be interpreted by the process of

evaporation. Deviations of the experimental results from the theoretical ones, especially for fragments, of larger energies, point to the fact that for a more detailed description of the mechanism of emission of fragments one must take into account also the details of the structure of the nuclei and also the participation of the cascading process. The nucleus which emits fragments $Z \geq 3$ is more strongly excited, while the median energy of excitation amounts to about 320 MeV. The similarity of the characteristics of the emission of hyperfragments and fragments points to the fact that there is no difference in the mechanism of emission of these fragments. This last result shows that the products of the interaction of K−mesons participate in all degrees of nuclear de-excitation. (Bull. Sci. Sect. A Sci. Nat. Tech. and Med.)

3672 EVIDENCE FOR A NEUTRAL MESON NEAR 1033 MeV. Garfinkel, A. F. (Purdue Univ., Lafayette, Ind.); Hoffman, E. W.; Jacobel, R. W.; (and others). Phys. Rev. Lett.; 29: No. 21, 1477-81(20 Nov 1972).

In a scintillation-counter experiment on the reaction $\pi^- + p \rightarrow M^0 + n$ at 2.4 GeV/c, evidence was obtained for a neutral meson denoted $M^0(1033)$ with a mass of 1032.6 ± 2.3 MeV and a width of $16.2^{+4}_{-3.8}$ MeV. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 4141.

3673 ELEMENTARY PROCESSES AT HIGH ENERGY. PART B. Ettore Majorana International Centre for Scientific Culture 1970 International School of Subnuclear Physics, Erice, Italy, July 1–19, 1970. Zichichi, A. (ed.). New York; Academic Press Inc. (1971). 437p. $29.50.

Fourteen lectures are included; a separate abstract is prepared for each lecture. (L.B.S.)

For abstracts of individual lectures see: 3079, 3632, 3666, 3688, 3721, 3722, 3753, 3775, 3776, 3863, 3877, 3883, 3901, and 4185.

General

Refer also to abstracts 3905 and 4371.

3674 (CERN-72-18) HIGH-ENERGY PHYSICS 25 YEARS AFTER THE DISCOVERY OF THE π MESON. Van Hove, L. (European Organization for Nuclear Research, Geneva (Switzerland)). 18 Oct 1972. 31p. Dep. NTIS (U. S. Sales Only).

A review is given of the state of high energy physics in 1947 and 1972 and the major developments in this period including hadron classification, hadronic currents and higher hadronic symmetries, high energy hadron collisions, and current problems and the future outlook. (J.F.P.)

3675 (CNRS-CPT-72-P-460) FIERZ–PAULI EQUATION FOR PARTICLES WITH SPIN $^3/_2$. Bellissard, J.; Seiler, R. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). Jun 1972. 8p. Dep. NTIS (U. S. Sales Only).

The Fierz−Pauli equation is considered for $s = {}^3/_2$ with a minimum of electromagnetic interaction. The Rarita−Schwinger formalism is used. The partial differential M_1 and M_2 operators of the first class have strictly hyperbolic determinants which can be calculated. The operators of the second class are expressed in terms of matrix valued functions, hermitian with respect to a positive definite scalar product. The knowledge of a fundamental E solution for $M_1^\dagger$ enables a fundamental E′ solution to be constructed for the partial differential L(D) operator of the wave equation, using a purely algebraic procedure. (France)

3676 (NP-19596) SEVENTH ANNUAL REPORT, 1971. (International Centre for Theoretical Physics, Trieste (Italy)). 69p. Dep. NTIS (U. S. Sales Only).

Theoretical research in nuclear, solid-state, and high-energy physics is summarized. A list of publications is included. (J.F.P.)

3677 LECTURES ON CURRENT ALGEBRA AND ITS APPLICATIONS. Treiman, S. B.; Jackiw, Roman; Gross, D. J. Princeton Series in Physics. Princeton, N. J.; Princeton University Press (1972). 371p. $14.50.

Three lectures are presented under the following headings: Current Algebra and PCAC; Field Theoretic Investigations in Current Algebra; and The High Energy Behavior of Weak and Electromagnetic Processes. A separate abstract is prepared for each lecture. (L.B.S.)

For abstracts of individual lectures see: 3706, 3751, and 3887.

3678 HIGH ENERGY PHYSICS. VOLUME V. Burhop, E. H. S. (ed.). Pure and Applied Physics, Volume 25-V. New York; Academic Press Inc. (1972). 291p. $16.50.

Three lectures are included: Photoproduction and Electroproduction Processes; Regge Phenomenology, and Analysis of Present Evidence on the Validity of Quantum Electrodynamics. A separate abstract is prepared for each lecture. (L.B.S.)

For abstracts of individual lectures see: 3705, 3888, and 3889.

3679 NEW PLOT FOR THE STUDY OF TRANSVERSE-MOMENTRUM CORRELATIONS IN TWO-PARTICLE INCLUSIVE REACTIONS. Korkea-aho, M. (Univ. of Helsinki). Lett. Nuovo Cim.; 5: No. 5, 398-400(30 Sep 1972).

A new way to present data and study correlations in transverse-momentum space is proposed for two-particle inclusive reaction. The method is based on the introduction of normalized variables in the transverse-momentum space, which can be represented as distances from the sides of an equilateral triangle with the height equal to 1. (L.B.S.)

3680 SEARCH FOR A THEORY OF MATTER. Sachs, Mendel. History of Science Series. New York; McGraw-Hill Book Company (1971). 222p. $6.95.

The various attempts to gather the laws that govern the motion of objects, electricity, magnetism, optics, gravitation and atomic and elementary particle physics into a satisfactory unified theory of matter are examined and illuminated. The topics covered range from the physics of ancient Greece through Galileo's studies of freely falling bodies, Newton's laws of motion and gravitation, Faraday's field concept, the theories of Maxwell and Morley, to Einstein's theory of relativity, Bohr's model of the atom and the modern quantum theory. (L.B.S.)

3681 NOTES ON ELEMENTARY PARTICLE PHYSICS. Muirhead, H. Elmsford, N. Y.; Pergamon Press, Inc. (1972). 259p. $13.75.

Seven chapters are included which forms an introductory course in elementary particle physics. The topics covered include terminology, transition amplitudes and probabilities, relativistic wave equations and fields, the interaction amplitude, electromagnetic interactions, weak interactions, and strong interactions. Recent developments in the theory of strong interactions (e.g. duality, the Veneziano formula) are included. (L.B.S.)

3682 RANDOM STAR GENERATION BY EXPANDING OF MULTILATERALS. Kopylov, G. I.; Nikitin, A. V.; Popova, V. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., B48: No. 1, 117-24(1972).

A new method of generation of random stars, a generalization of that of Van Hove, is proposed. The efficiency of the method is studied. (auth)

3683 ASYMPTOTIC EQUALITY OF CROSS SECTIONS FOR LINE-REVERSED REACTIONS. Cornille, H. (Institut de Physique Nucleaire, Orsay, France); Martin, A. Nucl. Phys., B48: No. 1, 104-16(1972).

It is shown that if the ratio $[(d\sigma/dt)(AB \rightarrow CD)]/[(d\sigma/dt)(\bar{C}B \rightarrow \bar{A}D)]$ has a generalized limit, for energies tending to infinity at fixed momentum transfer, this generalized limit is unity, if, in addition, the phases of the two amplitudes grow separately less fast than the logarithm of the energy. It is shown by explicit counter-examples that it is not sufficient to impose such a condition on the relative phase of the two amplitudes. Generalizations to non-fixed momentum transfer (case of a shrinking forward peak) are discussed. (auth)

3684 THEORETICAL PHYSICS: FROM CLASSICAL MECHANICS TO GROUP THEORY OF MICROPARTICLES. Mizushima, Masataka. New York; John Wiley and Sons, Inc. (1972). 709p. $22.00.

Chapters are included on principles of classical mechanics, simple harmonic oscillators, continuous body, rigid body, and rotating frame, special theory of relativity, electromagnetic fields, classical theory of radiation, general theory of relativity, quantum mechanics, one particle in a potential, relativistic quantum mechanics, and group theory in quantum mechanics. Appendices containing useful mathematical relations, formulas, and tables and aspects of the Kepler problem along with a subject index are also included. (C.E.S.)

3685 NONCOLLINEARITY OF VELOCITY AND MOMENTUM OF SPINNING PARTICLES. Costa de Beauregard, O. (C (CNRS, Paris). Found. Phys.; 2: No. 2-3(Apr 1972).

A theoretical and experimental search for the so-called Weyssenhof behavior of a spinning particle, due to the noncollinearity of its velocity and momentum, was undertaken. Z-independent

solutions of Maxwell's equations had previously been produced with a nonzero s^z component of the Poynting vector; indeed, Imbert emphasized that the spatial exponential damping of Fresnel's evanescent wave would entail a nonzero value for the integral $\int\int s^z\,dx\,dy$. Excellent experimental verifications of this point have been obtained by Imbert. Besides having no z component of their momentum, the energy-momentum quanta inside Fresnel's evanescent wave have typical tachyon properties, the imaginary character of their y component (normal to the reflecting surface) entailing that (in units such that c = 1) their x component is larger than the energy quanta. Imbert is now planning experiments to test these interesting properties. Thus, the two main aspects of noncollinearity of velocity and momentum of spinning particles would be displayed. (auth)

3686 NONLOCALITY AND GENERALIZED ANALYTICITY. Tran hu'u Phat (Hanoi Univ., Vietnam). Acta Phys. Pol., B3: No. 5, 565-74(1972).

It is shown that for the nonlocal theory of Snyder's type dispersion amplitudes are generalized analytic functions of their arguments. The true test of the microcausality at high energies are indicated. (auth)

3687 WAVE FUNCTIONS OF FAST-MOVING TWO-BODY SYSTEMS. Chylinski, Z. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol., B3: No. 5, 575-83(1972).

A hypothesis is proposed which concerns the description of two-body systems in fast motion. The main idea consists in the determination of an absolute three-dimensional space spanned on the absolute coordinates such as those introduced by Kadyshevskii. The proposed framework results implicitly in the distinguished role of the overall center of mass system in accounting for the internal dynamics of an isolated system. The example of two spinless particles is presented which, despite its relative simplicity, exhibits the most important aspects of the proposed framework. (auth)

3688 WEAK PCAC. Preparata, G. (Univ., Rome). pp 618-47 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

A review is given of the development of the ideas and applications of PCAC. The following topics are covered: symmetry breaking; PCAC and the chiral world; weak PCAC; mass-dispersion relations and corrections to PCAC; and soft-pion extrapolation theory. Some applications are discussed: the K_{l3} form factors and the πN low-energy theorems. (L.B.S.)

3689 LAGRANGIAN FORMULATION AND CURRENT ALGEBRA IN THE NEVEU–SCHWARZ DUAL MODEL. Ademollo, M.; Barducci, A.; Gomis, J. (Univ., Florence). Nuovo Cim.; 12A: No. 1, 263-78(1 Nov 1972).

The field theory formulation in co-ordinate space of the Neveu–Schwarz model for the N-pion amplitude and for the N-pion emission from a single quark line is studied in some detail. Then the problem of current algebra for the fermion and for the boson case is considered. In particular for the boson case a class of axial currents which satisfy the local $SU_2 \times SU_2$ algebra with the isospin currents and the PCAC relation between external real states is found. (auth)

3690 SIMPLE QUARK MODEL LIGHT-CONE ALGEBRA DOES NOT IMPLY THAT REAL QUARKS EXIST. Orzalesi, C. A. (Freie Univ., Berlin). Lett. Nuovo Cim.; 5: No. 7, 581-3(14 Oct 1972).

Trivial counterexamples are constructed to refute claims that a light cone behavior indicates a free-quark light cone propagation in deep inelastic scattering and that a light cone behavior should also imply that quarks be found in physical scattering states. It is found that a light cone behavior of the current–current product does not imply that the underlying field has a particle interpretation. By considering a similar example with Dirac fields, one sees that the light cone algebra of bilocal operators considered previously does not require that real quarks must be observed in initial or final scattering states. (J.F.P.)

3691 ASYMMETRIES OF MULTIPLICITY CROSS SECTIONS. Nussinov, S.; Quigg, C.; Wang, J. M. (State Univ. of New York, Stony Brook). Phys. Rev., D; 6: No. 9, 2713-14(1 Nov 1972).

Front-back asymmetries of multiplicity distributions are shown to discriminate among pictures of multiparticle reactions. (auth)

3692 COMPOSITE THEORY OF INCLUSIVE SCATTERING AT LARGE TRANSVERSE MOMENTA. Gunion, J. F.; Brodsky, S. J.; Blankenbecler, R. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 9, 2652-8(1 Nov 1972).

The bound-state model which was previously used to describe elastic hadronic scattering is applied to the inclusive reactions $A + B \rightarrow C + X$. The force due to the interchange of common constituents is predicted to be the dominant interaction in inclusive reactions at large transverse momenta, just as it is in large-angle exclusive scattering. In the simplest cases the power-law falloff of the hadronic wave function allows effective current operators to be introduced which are the analogs of the lepton-photon current in deep-inelastic electron-proton scattering. The predictions for the inclusive cross section take the form of a definite power of s times a scale-invariant function of the remaining invariants which can be simply related to the structure function $\nu W_2(x)$ of the target. It is shown that in most cases the model predicts the same s dependence at fixed missing mass for the incoherent background as for the exclusive resonance contribution to the inclusive cross section. Results for several specific hadron- and photon-induced inclusive reactions are given. (auth)

3693 ELEMENTARY PARTICLES. FRONTIERS OF HIGH ENERGY PHYSICS. Wick, G. L. Open Library Science. London; Geoffrey Chapman (1972). 125p.

The basic principles of the structure of matter, quantum mechanics and the production and detection of elementary particles of various kinds are discussed. The subject is then developed: the forces of nature (forces on the atomic level, strength and range of a force, the force propagator, parity, theta-tau puzzle, the cobalt-60 experiment, neutrino's spin direction, pion decay, superweak force, superstrong force); symmetries and conservation laws (momentum conservation, measuring a particle's mass, resonances, angular momentum conservation, spin quantum number, neutrino's spin, electric charge, baryon and lepton conservation, partial symmetries, parity, charge conjugation, isotopic spin and its violation, strange particles, strangeness); classification of elementary particles (the eightfold way, charge multiplets, supermultiplets, meson, baryon and high-spin resonances, hypercharge, quarks, dynamical structure, leptons, the photon); select problems from modern research (internal structure of the proton and of the neutron, Rutherford scattering, the wavelength of particles, the proton's electromagnetic structure, virtual particles, virtual meson cloud, repulsive core, partons and bootstraps, CP violation in kaon decays, properties of kaons, preserving CPT, eta decay). (UK)

3694 GENERALIZATION OF GEOMETRICAL DUALITY. Takagi, Fujio (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto); 48: No. 3, 900-15(Sep 1972).

A concept of geometrical duality (a geometrical picture for two-component duality) is extended to general two-body-two-body processes involving in general virtual particles, such as Reggeons, pomerons and virtual photons in addition to real hadrons or photons. This generalization enables one to analyze in a unified way various types of high energy reactions, such as elastic, inelastic-two-body, quasi-two-body scattering, multiple production, inclusive reactions, deep inelastic electron scattering and so on from the viewpoint of geometrical duality. This model predicts a kind of geometrical scaling. It is pointed out that there is a remarkable similarity between the model and Leader-Pennington's model based on a new kinematical variable. (auth)

3695 DIFFERENCE EQUATION AND DUAL RESONANCE MODEL. Naka, Sigefumi (Nihon Univ., Tokyo). Progr. Theor. Phys. (Kyoto): 48: No. 3, 1024-36(Sep 1972).

Relativistic quantum mechanics of the particle obeying a difference equation is studied in connection with the dual resonance model. It is shown that such a system has finite time-like extension and leads to the same results as in the case of conventional string models of hadrons. (auth)

Electromagnetic

Refer also to abstracts 2595, 3289, 3454, 3628, 3634, 3902, 3912, and 3994.

3696 (CLNS–160) TRIPLE- REGGE MODEL FOR INCLUSIVE PHOTO- AND ELECTROPRODUCTION. Terazawa, Hidezumi (Cornell Univ., Ithaca, N. Y. Lab. of Nuclear Studies). Jun 1971. 10p. (CONF-710816–32).

From International symposium on electron and photon interactions at high energies; Ithaca, NY. (23 Aug 1971).

By assuming triple-Regge behavior, definite predictions are made for inclusive photoproduction $\gamma + p \rightarrow c +$ anything and electroproduction $e(\mu) + p \rightarrow e(\mu) + c +$ anything (where c is a stable hadron). These predictions give a crucial test of the model. (auth)

3697 (CONF-710816–29) ELECTROPRODUCTION COINCIDENCE CROSS SECTIONS FROM COUPLED MULTIPOLE

EQUATIONS. Gehlen, G. v.; Wessel, H. (Bonn Univ. (West Germany). Physikalisches Institut). Aug 1971. 120p. Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, NY. (23 Aug 1971).

Detailed results of a dispersion calculation of electroproduction coincidence cross sections in the region of the $\Delta(1232)$ at momentum transfers $\lambda^2 = 2.5$, 5, 7.5, 10, 15, 25, and 40 fm^{-2} are presented. The results are used for a semi-experimental determination of the three $(\gamma N\Delta)$-form factors from the resonant multipoles. Also the detailed photoproduction cross sections and asymmetries are given which are obtained from the calculation in the limit $\lambda^2 \to 0$. (auth)

3698 (DESY–72/46) QUASI TWO BODY e^+e^- ANNIHILATION. Kramer, G.; Walsh, T. F. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1972. 43p. Dep. NTIS (U. S. Sales Only).

The helicity formalism for e^+e^- annihilation into two-body resonance states is presented, and it is shown how to systematically extract the magnitudes and relative phases of the form factors present in the one-photon exchange approximation. This entails measurement of one-particle density matrices and certain polarization correlations in the final state. As an example, the vector meson dominance expectations for annihilation into meson resonances are discussed, and it is shown how this model can be tested. (auth)

3699 (LNF–72/66) PSEUDOSCALAR MESON DECAYS INTO LEPTON PAIRS AND THE LEE–WICK THEORY. Bramon, A. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 11 Jul 1972. 8p. Dep. NTIS (U. S. Sales Only).

The branching ratios $R_{P\to 1\bar{1}} \equiv \Gamma(P \to 1\bar{1})/\Gamma(P \to \gamma\gamma)$ are evaluated using the Lee and Wick theory of QED and assuming that the $f_{P\gamma\gamma}$ couplings are independent of the virtual photon masses. From the experimental value $R_{\eta\to\mu^+\mu^-} = (5.9 \pm 2.2)\ 10^{-5}$ one obtains $m_B = 32^{+40}_{-18}$ GeV and $R_{\pi^0\to e^+e^-} = (2.2 \pm 0.4)\ 10^{-7}$. (auth)

3700 (LNF–72/67) POSSIBILITY OF MEASURING MESON AND BARYON ELECTROMAGNETIC STRUCTURE FUNCTIONS USING NAL AND ISR. Pancheri-Srivastava, G.; Srivastava, Y. N. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 14 Jul 1972. 8p. Dep. NTIS (U. S. Sales Only).

Experiments are proposed to measure the π^+, π^-, K^+ and K^- electromagnetic form factors and inelastic structure functions. The reaction projectile + proton → proton + anything is discussed. (J.F.P.)

3701 (NP–19478) PROBLEM OF CONTINUATION FROM DEEP INELASTIC ELECTRON SCATTERING TO DEEP ELECTRON–POSITRON ANNIHILATION. Internal Note No. 378. Gatto, R.; Preparata, G. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 22 May 1972. 32p. Dep. NTIS (U. S. Sales Only).

The problem of continuing from deep inelastic scattering to deep inelastic annihilation is studied. It is shown that by requiring that the total annihilation hadronic cross section behaves like the "point-like" cross section leads to nontrivial Bjorken scaling for the deep inelastic annihilation; which is however not obtainable in general from the deep inelastic scattering. Some considerations on the general problem of crossing are also presented. (auth)

3702 (NP–19585) INFRARED DIVERGENCES AND ADIABATIC SWITCHING. II. RADIATIVE CORRECTIONS TO COULOMB SCATTERING. Barbieri, R.; Remiddi, E. (Bonn Univ. (West Germany). Physikalisches Institut). Aug 1972. 13p. Dep. NTIS (U. S. Sales Only).

A previous method based on the adiabatic switching procedure is shown to be applicable for the evaluation of the first-order radiative corrections to electron scattering in an external field. This problem is of interest in the development of quantum electrodynamics. (J.F.P.)

3703 (ORO–3992-90) STABILITY OF THE CLASSICAL ELECTRON. Chiang, C. C. (Texas Univ., Austin. Center for Particle Theory). Jun 1972. 8p. (CPT–143). Dep. NTIS.

It is shown that in the classical theory of the electron, with the introduction of a shadow electromagnetic field, the electron is stable in the point particle limit. (auth)

3704 (ORO–3992-91) OPTICAL DISPERSION RELATIONS WITH FINITE WAVE PACKETS. Rechenberg, H. (Texas Univ., Austin. Center for Particle Theory). Jun 1972. 35p. (CPT–144). Dep. NTIS.

The causal propagation of light through matter was expressed in terms of dispersion relations promoting the view that nonanalytic scattering amplitudes might lead to observable, macroscopically acausal effects. A simplified model of classical dispersion of light is investigated in which wave packets are used that cannot be confined to an infinitely small space region at an instant of time. The "nonlocalizability" in microscopic domains expressed through this construction results in a modification of classical dispersion relations. Though no macroscopically acausal effects arise in the diffraction of finite light signals, the scattering amplitude and consequently also the refractive index cease to be analytic functions outside regions determined by a maximal frequency. The latter also defines the extension of the wave packet. (auth)

3705 PHOTO- AND ELECTROPRODUCTION PROCESSES. Donnachie, A. (Daresbury Nuclear Physics Lab., Warrington, Eng.). pp 1-185 of High Energy Physics. Vol. V. /Burhop, E. H. S. (ed.). New York; Academic Press Inc. (1972).

The first section is concerned primarily with the details of pion photoproduction and electroproduction: the kinematics, the choice of invariant amplitudes and their properties, the multipole amplitude and helicity amplitude expansions of the transition matrix, the Born terms, and cross section and polarization formulas. The second section explores the scope and success of dispersion theory in pion photoproduction and electroproduction in the region of the first resonance. The phenomenological analyses of the data on photoproduction and electroproduction of the N* resonances are discussed. A discussion is then given on the quark model. An outline of the Regge pole formalism is given in the third section, followed by its application to forward and backward photoproduction of pseudoscalar mesons and the forward production of vector mesons. The vector dominance model is first introduced in the discussion of vector meson photoproduction on complex nuclei, and is then extended and applied to meson photoproduction generally. The section ends with a brief account of the recent developments in high energy electroproduction. (L.B.S.)

3706 HIGH ENERGY BEHAVIOR OF WEAK AND ELECTROMAGNETIC PROCESSES. Gross, D. J. pp 255-362 of Lectures on Current Algebra and Its Applications. Treiman, S. B. Princeton, N. J.; Princeton Univ. Press (1972).

The lecture on the high-energy behavior of weak and electromagnetic processes covers the following topics: elastic form factors and photon-hadron scattering; inelastic electron-hadron scattering; applications of current algebra; scaling, anomalies, and light cone behavior; parton models; and Regge poles and duality in the scaling region. (L.B.S.)

3707 GENERALIZED VECTOR DOMINANCE AND INELASTIC ELECTRON–NUCLEON SCATTERING: THE NEUTRON-TO-PROTON RATIO. Sakurai, J. J.; Schildknecht, D. (Univ. of California, Los Angeles). Phys. Lett.; 41B: No. 4, 489-94(16 Oct 1972).

Within the framework of generalized vector dominance, attempts are made to understand the observed neutron-to-proton ratio in inelastic electron-nucleon scattering. (auth)

3708 CONTRIBUTION OF ρ' TO THE CHARGE RADIUS OF THE PION. Buchl, R. A.; Nigam, B. P. (Arizona State Univ., Tempe). Lett. Nuovo Cim.; 5: No. 5, 401-2(30 Sep 1972).

The pion form factor is written taking into account the contributions from the ρ and the proposed $\rho'(1685)$ vector mesons. The charge radius is then extracted from the pion form factor. (L.B.S.)

3709 HADRON MULTIPLICITIES IN A SCALING MODEL FOR e^+e^- ANNIHILATION. Altarelli, G. (Univ., Rome); Maiani, L. Phys. Lett.; 41B: No. 4, 480-4(16 Oct 1972).

A study of the annihilation of a vector current into spinless particles in the framework of the ladder model is presented. On the basis of the results here reported, it is conjectured that in e^+e^- annihilation into hadrons a finite limit for the multiplicity of any type of particle produced will be attained at large q^2 together with a scaling regime for total cross section ($\sigma_{e^+e^-} \sim 1/q$). (auth)

3710 RADIATIVE CORRECTIONS TO THE PHOTON–GRAVITON VERTEX. Delbourgo, R.; Phocas-Cosmetatos, P. (Imperial Coll. of Science and Tech., London). Phys. Lett.; 41B: No. 4, 533-5(16 Oct 1972).

The lowest order electromagnetic corrections to the $\gamma\gamma g$ vertex due to a charged boson or fermion loop are evaluated and correspond to the effective quadrupole interaction $\frac{1}{4}\alpha(-1)^{2J}(2J+1)$ $g^{\mu\nu}F_{\kappa\lambda}\partial_\mu\partial_\nu F_{\kappa\lambda}/720\pi M^2$ where J and M are the spin and mass of the particle in the quantum loop. Unfortunately the chances of subjecting this result to experimental test, either at present accelerator energies or by astronomical observation, are remote. (auth)

3711 EQUATIONS OF MOTION IN EINSTEIN'S UNIFIED FIELD THEORY. Klotz, A. H.; Russell, G. K. (Univ. of Sydney). Acta Phys. Pol., B3: No. 5, 649-58(1972).

It is shown that the field equations of the nonsymmetric unified field theory imply equations of motion of a charged test particle with an electromagnetic force term. This result is contingent on the electromagnetic field tensor being suitably expressed in terms of the fundamental tensor. A conjecture of Wyman on the boundary conditions is adopted, and it is shown that to the required order of approximation the electromagnetic force consists of a Lorentz term together with a small correction term, linearly dependent on distance and similar to the Hubble law of cosmic repulsion. It is thus very different from the corrections previously contemplated (Treder 1957). These results remove a major objection to Einstein's unified field theory. The appearance of what is essentially a correction term to a Coulomb field is a firm prediction of the theory, capable in principle of an empirical verification. (auth)

3712 EFFECT OF THE POLARIZATION OF ELECTRONS AND γ QUANTA ON THE PROCESS OF TWO-PHOTON BREMSSTRAHLUNG OF ELECTRONS IN THE FIELD OF A NUCLEUS. Nadzhafov, I. M. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 7, 13-18(1972). (In Russian).

An integration of the cross section of two-photon bremsstrahlung [$e + (Ze) \rightarrow (Ze)' + e' + \gamma_1 + \gamma_2$] with respect to the angle of electron scattering and the angle of emergence of decelerated photons was performed. There were obtained expressions which characterized the energy, angular, and the polarized distribution of the cross section. It was shown that the cross section of two-photon bremsstrahlung in the case of parallel momenta of decelerated photons may predominate over the corresponding Bethe–Heitler cross section. The probability of some polarized states of electrons was also investigated. (tr-auth)

3713 VAVILOV–CHERENKOV EFFECT AND THE DOPPLER EFFECT IN THE CASE MOTION OF THE SOURCES WITH VELOCITY EXCEEDING THE SPEED OF LIGHT IN VACUUM. Bolotovskii, B. M.; Ginzburg, V. L. (Lebedev Inst. of Physical Chemistry, Moscow). Usp. Fiz. Nauk; 106: No. 4, 577-92(Apr 1972). (In Russian).

The radiation emitted by sources traveling at a velocity of $v > c$ has not been thoroughly investigated until only very recently; the new concepts originated by the authors are further examined. The velocity of the "light spot" of a pulsar on the earth was taken as an example. The fundamental laws of reflection and refraction of light at a plane interface of 2 media agree with conditions of the Vavilov–Cherenkov radiation from a source flying along the boundary. It has been generally accepted previously that the Vavilov–Cherenkov effect and the anomalous Doppler effect may be observed only in case of waves which satisfy the condition of $c/n < v < c$, having an index of refraction $n(\omega) > 1$; therefore, it was assumed that such a phenomenon can occur only in vacuum. It is shown that sources moving with a velocity of $v > c$ are able to generate Vavilov–Cherenkov radiation in any medium, exhibiting the same characteristics, i.e., anomalous Doppler effect, as "ordinary" sources. Although theoretically possible, it is difficult to foresee at present the application of such sources to the generation of x radiation. "Superfast" sources may be encountered in astronomy; emission of electromagnetic, gravitational and possibly neutrino waves from such sources presents a great interest for physics. (TTT)

3714 CLASSICAL RELATIVISTIC THEORY OF POINT-LIKE PARTICLES. Bialynicki-Birula, I. (Inst. for Theoretical Physics, Warsaw). Ark. Fys. Seminar Trondheim; No. 8, vp(1972).

The difficulties which are encountered in the description of point-like particles interacting with the electromagnetic field are examined and a method of constructing a consistent theory is discussed. An exactly soluble model is used to show how this method works. (auth)

3715 RELATIONSHIP BETWEEN FORM FACTORS OF ELASTIC AND INELASTIC ELECTRON SCATTERING. Lazarenko, L. A.; Soroka, V. A. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 8, 1353-55(Aug 1972). (In Russian).

Relations were found (within the limits $q^2 \rightarrow -\infty$, $p_0 \rightarrow \infty$) for scattering processes by polarized and unpolarized targets. Integral quantities appeared in the development which were expressed by form factors of elastic and inelastic scattering of electrons. From the conditions inherent in the rest of the development and its conformal invariance, a relation between the form factors was derived. (K.S.W.)

3716 NEW METHOD OF REDUCTION OF QUASI-RELATIVISTIC EQUATIONS TO THE SUBSPACE OF POSITIVE ENERGY STATES. Janyszek, H. (Copernicus Univ., Torun, Poland). Acta Phys. Pol., B3: No. 5, 621-36(1972).

A new method of reduction of an arbitrary quasirelativistic quantum-mechanical equation for two charged Dirac particles to the Pauli formalism is presented. The advantages of this method are: it gives a criterion for choosing the most suitable form of quasirelativistic equation from among apparently equivalent alternative possibilities, it permits considerable simplification of formal calculations and provides some demonstrative interpretation of intermediate results, it makes possible direct generalization of results to arbitrary number of identical or different fermions, it leads to the definition of other particle observables (understood in the sense of Foldy–Wouthuysen "mean operators") which together with the Hamiltonian determine the basis of quantum-mechanical description of such systems. (auth)

3717 KAON ELECTROMAGNETIC FORM FACTOR IN A VENEZIANO-TYPE REPRESENTATION. Chia, T. C. (Dalhousie Univ., Halifax, Nova Scotia). Can. J. Phys.; 50: No. 14, 1652-5(15 Jul 1972).

A simple form of the kaon electromagnetic form factor in a Veneziano-type representation is investigated. With the conjecture of Yang et al. and Elitzur's scaling hypothesis for hadronic form factors, the kaon form factor is linked to and compared with high energy $K + p \rightarrow K + p$ and $K + p \rightarrow K^* p$ scattering data. The results are found to be satisfactory. (auth)

3718 PHASES OF BACKWARD PION PHOTOPRODUCTION AMPLITUDES. Alvarez-Estrada, R. F. (Junta de Energia Nuclear, Madrid); Carreras, B.; Sanchez-Gomez, J. L. Nucl. Phys., B48: No. 1, 141-56(1972).

A detailed study of the analytic structure of backward pion photoproduction amplitudes is made, and dispersive representations for their phases in terms of their modulus (which are directly related to differential cross sections over most of the integration region) are presented. Numerical evaluations of one of those representations for backward $\gamma p \rightarrow n\pi^+$ in the first resonance region are performed, and approximate values of the corresponding phase over the second resonance region are predicted. (auth)

3719 SPACE–TIME CORRELATION OF SYNCHROTRON RADIATION FIELD. Mazmanishvili, A. S.; Shenderovich, A. M. (Physical-Technical Inst., Kharkov). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 15: No. 6, 873-81(1972). (In Russian).

The statistics of the field of synchrotron radiation from relativistic electrons in a synchrotron was considered. Analysis is made for the arbitrary electron number with account of the statistical fluctuations of their location at the orbit. The dependence is obtained of the correlation functions for the phase extension of a cluster and the electron number. In the stationary case the space–time dependences of the correlation functions were obtained. (auth)

3720 GEODESICS OF AN EINSTEIN CONNECTION AND THE LYTTLETON–BONDI ELECTRODYNAMICS. Burman, R. R. (Univ. of Western Australia, Nedlands). Indian J. Pure Appl. Phys.; 10: No. 1, 63-4(Jan 1972).

Paths of charges in the Lyttleton–Bondi electrodynamics are expressed as geodesics of an affine connection satisfying a basic geometrical principle of Einstein's unified field theory. (auth)

3721 PROBING THE LIGHT CONE. Brandt, R. A. (CERN, Geneva). pp 472-509 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

A discussion is given on a class of phenomena in particle physics which can be related to the behavior of quantum field operators near the light cone. This class includes lepton–hadron scattering experiments in which a very massive current interacts with a hadronic system in a high energy inelastic collision. An appropriate operator formalism for describing light-cone behavior in quantum field theory is developed and applied to the study of a number of examples in the above class: electroproduction, μ-pair production, and vector meson dominance. (L.B.S.)

3722 PRELIMINARY RESULTS ON BHABHA SCATTERING, MUON PAIR ANNIHILATION, AND HADRON PRODUCTION BY e^+,e^- COLLIDING BEAMS IN THE GeV REGION. Conversi, M. (Univ., Rome). pp 548-81 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

Results are reported of a preliminary analysis of data collected on the following reactions at total energies between 1.6 and 2.0 GeV: $e^+ + e^- \rightarrow e^+ + e^-$; $e^+ + e^- \rightarrow \mu^+ + \mu^-$; $e^+ + e^- \rightarrow h^+ + h^-$; and

$e^+ + e^- \rightarrow mh^+ + mh^- + nh^0$, where h indicates a hadron and $n \geq 0$ when $m > 1$, $n \geq 1$ if $m = 1$. Details are given of the main apparatus and the monitoring system. (L.B.S.)

3723 VECTOR-MESON DOMINANCE IN INCLUSIVE REACTIONS. Murai, N.; Phua, K. K. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 5: No. 7, 575-80(14 Oct 1972).

The photon fragmentation region in the inclusive reaction $\gamma + p \rightarrow \pi^- +$ anything is studied under the assumptions of the pion spectrum resulting from the resonance decay, the vector meson dominance model, and the favored distribution of $\gamma \rightarrow \varphi^0$. The pion distribution is calculated. (J.F.P.)

3724 LIGHT-CONE DOMINANCE OF TIME-ORDERED PRODUCTS AND FIXED SINGULARITIES IN THE J-PLANE. de Alwis, S. P. (Univ. of Cambridge, Eng.). Lett. Nuovo Cim.; 5: No. 7, 553-7(14 Oct 1972).

The consequences of the assumption that the time-ordered product of two electromagnetic currents has a canonical singularity structure are investigated. Gluon-type models for the currents are used in so far as the Lorentz tensor structure for the product of the two currents near the light cone is abstracted from them. The off-shell Compton scattering amplitude on protons is considered. (J.F.P.)

3725 ELECTROMAGNETIC INTERACTIONS BETWEEN PARTICLES WITH ARBITRARY SPIN, BASED UPON WEINBERG'S EQUATION. II. PROPAGATORS AND HIGHER-ORDER PROCESSES. Eeg, J. O. (Univ. of Oslo). Lett. Nuovo Cim.; 5: No. 8, 591-4(21 Oct 1972).

A presentation of some problems which arise in the construction of an electrodynamics for Weinberg's equation following the Feynman approach is given. The problems arise because the Weinberg equation has, in addition to the physical mass solution, also $2s - 1$ false solutions. It is concluded that because of the false solutions, an electrodynamics for Weinberg particles will have evident weaknesses. (J.F.P.)

3726 COMPTON SCATTERING AND THE COUPLINGS OF f, σ, η, A_2 AND π TO PHOTONS AND NUCLEONS. Baacke, J.; Chang, T. H.; Kleinert, H. (Institut fuer Theoretische Physik, Berlin). Nuovo Cim.; 12A: No. 1, 21-61(1 Nov 1972).

The technique of equating unsubtracted dispersion relations in the forward and backward directions at threshold in order to obtain sum rules for the invariant amplitudes of Compton scattering is used. Assuming f, σ, η and π, A_2 to dominate the absorptive part of the t-channel, and baryon resonances to saturate the integrals over the s- and u-channel cuts one can express the coupling constants of these mesons to photons and nucleons in terms of the electromagnetic multipole amplitudes of the baryon resonances. The results are compared with estimates obtained by other methods. (auth)

3727 DUAL-RESONANCE MODEL FOR INCLUSIVE DISTRIBUTIONS IN HIGH-ENERGY ELECTRON-POSITRON ANNIHILATION. Satz, H. (Univ. of Bielefeld, Ger.). Nuovo Cim.; 12A: No. 1, 205-14(1 Nov 1972).

By means of a generalized optical theorem, the single-particle distribution for $e^+e^- \rightarrow$ hadron plus anything is calculated in the one-photon approximation from a dual-resonance model for virtual Compton scattering. Implications on the relation between the dual-resonance and the thermodynamical models are discussed. (auth)

3728 MODEL OF WEAK AND ELECTROMAGNETIC INTERACTIONS. Tonin, M. (Univ., Padua). Lett. Nuovo Cim.; 5: No. 8, 635-9(21 Oct 1972).

A model is proposed which postulates only fractionally charged quark triplets to describe the hadronic structure of weak and electromagnetic interactions. The gauge on which the model is based is $SU(2) \times U(1)$. The basic idea of the model is that weak interactions are able to distinguish between the three triplets which are identical under strong interactions. The model is free from the Adler anomalies problem. The $\Delta S = 1$ neutral currents are not present in the original Lagrangian nor are they induced to order $G(GM_w^2)$. And finally, universality can be imposed if, for instance, the second model of Prentki and Zumino is assumed for the leptons. (J.F.P.)

3729 MUON PAIR CREATION VIA TWO-PHOTON EXCHANGE IN CHARGED-PARTICLE COLLISIONS. I. ELECTRON COLLISIONS. Fujikawa, K. (Univ. of Chicago). Nuovo Cim.; 12A: No. 1, 83-116(1 Nov 1972).

Muon pair creation via two-photon exchange in electron collisions is discussed on the basis of analytical QED formulas. The total cross section, the invariant-mass distribution and the q^2-dependence of the cross section are given. These formulas are valid for electron energies larger than 1 GeV. Large-q^2 behavior is studied in detail in connection with the deep inelastic process on the photon target. The present process shows an interesting "scaling" behavior and it is about an order of magnitude larger than the expected deep inelastic process. Also formulas for the muon pair bremsstrahlung process are derived. These formulas explicitly show various interesting properties observed in numerical calculations. The cross section of this process is small compared with that of the nearly on-shell two-photon exchange process. However, the result shows that the bremsstrahlung process may provide a serious background to the photon deep inelastic process at low energies. (auth)

3730 MUON PAIR PRODUCTION IN ELECTRON-POSITRON ANNIHILATION AND THE BJORKEN-JOHNSON-LOW LIMIT. Ahmed, M. A. (Univ. of Khartoum, Sudan). Phys. Rev., D; 6: No. 9, 2709-13(1 Nov 1972).

Electron-positron annihilation leading to the production of a muon pair and a system of hadrons is investigated in the Bjorken-Johnson-Low asymptotic limit. The equal-time commutators are calculated from light-cone expansions and expressions for differential cross sections obtained. Comparison with the work of Gross and Treiman is made. (auth)

3731 VIRTUAL-PHOTON TOTAL CROSS SECTIONS ON NUCLEI AND THE PHASES BETWEEN TWO-BODY AMPLITUDES. Bochmann, G. V. (Univ. of Montreal). Phys. Rev., D; 6: No. 9, 2715-17(1 Nov 1972).

Experimental results of virtual-photon total cross sections on nuclei are explained in terms of an eikonal model and the corresponding two-body amplitudes $f_{\gamma\rho}$ and $f_{\gamma\gamma}$. The relative phase between these amplitudes has a strong influence on the resultant total cross section and the amount of nuclear shadow observed in the reaction. Given experimental data with fewer uncertainties, this phase could be determined from two-body cross sections and the total cross section on nuclei. (auth)

3732 LOW-ENERGY THEOREMS AND HIGH-ENERGY BEHAVIOR. Creutz, Michael (Univ. of Maryland, College Park). Phys. Rev., D; 6: No. 9, 2483-7(1 Nov 1972).

The constraints at high energy that analyticity imposes on amplitudes given a low-energy theorem and an upper bound to the amplitude at intermediate energies are studied. These constraints prove to be nontrivial when applied to the pion electromagnetic form factor. It is suggested that the results may be useful in a future analysis of the contribution of the spin-dependent forward Compton amplitude to unpolarized Compton scattering. This application will require experimental data on the forward differential cross section in the resonance region. (auth)

3733 TEST FOR FRACTIONALLY CHARGED PARTONS FROM DEEP-INELASTIC BREMSSTRAHLUNG IN THE SCALING REGION. Brodsky, S. J.; Gunion, J. F.; Jaffe, R. L. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 9, 2487-94(1 Nov 1972).

It is shown that measurements of deep-inelastic bremsstrahlung, $e^\pm + p \rightarrow e^\pm + \gamma +$ anything, in the appropriate scaling region will provide a definitive test for fractionally charged constituents in the proton, provided the parton model is valid. More precisely, measurement of the difference between the scaling inclusive bremsstrahlung cross sections of the positron and electron will allow the determination of a proton structure function V(x) which, unlike the deep-inelastic e-p structure functions, obeys an exact sum rule based on conserved quantum numbers. In particular, it is shown that $\int_0^1 dx\, V(x) = \frac{1}{3}Q + \frac{2}{3}B$ ($= \frac{5}{9}$ for a proton target) in the quark model, whereas $\int_0^1 dx\, V(x) = Q$ in the case of integrally charged constituents. Since the result is independent of the momentum distribution of the partons, the sum rule holds for nuclear targets as well. Since V(x), which involves the cube of the parton charge, is related to odd-charge-conjugation exchange in the t channel, Pomeranchukon, and other C-even contributions are not present, so that V(x) should have a readily integrable quasielastic peak. This, combined with the fact that there exists a simple kinematic region in which the difference is of the same order as the inclusive bremsstrahlung cross sections themselves, and the fact that there is no hadronic-decay background, should make this a feasible experiment on proton and nuclear targets. (auth)

3734 SCHWARZ INEQUALITY FOR ONE-PHOTON ANNIHILATION, ELECTROPRODUCTION, AND THE TWO-PHOTON PROCESS. Terazawa, Hidezumi (Rockefeller Univ., New York). Phys. Rev., D; 6: No. 9, 2530-2(1 Nov 1972).

It is demonstrated that the Schwarz inequality gives useful relations between the one-photon annihilation process $e^+ + e^- \rightarrow$ any hadrons, the electroproduction $e + A \rightarrow e +$ anything, and the two-photon process $e^\pm + e^- \rightarrow e^\pm + e^- A$, where A is an arbitrary hadronic state with positive charge conjugation. Particularly, the $\pi^0\gamma\gamma$ vertex function, if it decreases at all, is shown to decrease

not slower than $(-q^2)^{-\frac{1}{4}}$ as one of the virtual-photon masses q^2 increases. Possible applications to various other processes are suggested. (auth)

3735 ELECTROPRODUCTION OF NUCLEON RESONANCES WITH POLARIZED LEPTONS. Close, F. E.; Gilman, F. J.; Karliner, I. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 9, 2533-41(1 Nov 1972).

The electroproduction of nucleon resonances with polarized leptons and a polarized nucleon target is considered and compared with what is expected to be the behavior of deep-inelastic polarized scattering. A set of nucleon resonances in the symmetric quark model is found such that their excitation gives the same results for the ratio of neutron to proton inelastic scattering and for the polarization asymmetry on protons and neutrons as does the naive quark-parton model. However, the symmetric quark model with harmonic forces predicts dramatic variations in the helicity structure of the excitation of the prominent nucleon resonances, which are not supported by the existing data. Additional tests of the symmetric quark model and a discussion of what is known of resonance excitation with what is expected in polarized deep-inelastic scattering are presented. (auth)

3736 INCLUSIVE SPECTRA IN DEEPLY INELASTIC ep COLLISIONS. Quigg, C.; Wang, J. M. (State Univ. of New York, Stony Brook). Phys. Rev., D; 6: No. 9, 2690-2(1 Nov 1972).

A picture of ep collisions is developed which is in the spirit of recent speculations concerning multiplicity fluctuations in high-energy collisions. The implications for experimental studies are analyzed. (auth)

3737 MOTION OF CHARGED PARTICLES IN HOMOGENEOUS ALTERNATING MAGNETIC FIELDS. Glikman, L. G. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 5, 769-73(Nov 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 5, 972-7(May 1972).

A study is made of the motion of charged particles in a homogeneous alternating axisymmetric magnetic field in the relativistic and nonrelativistic cases. Upper and lower bounds are obtained for the particle energy and the distance of the particle from the symmetry axis of the field. It is shown that if the absolute magnitude of the magnetic field $|H(t)|$ varies monotonically, the maxima and minima of the function $r(t)$ (r is the distance of the particle from the symmetry axis of the field) decrease or increase monotonically, depending on whether $|H(t)|$ increases or decreases. (auth)

3738 BOUNDS FOR THE ENERGY OF A CHARGED PARTICLE MOVING IN AN ALTERNATING AXISYMMETRIC MAGNETIC FIELD. Glikman, L. G. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 5, 774-6 (Nov 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 5, 978-80(May 1972).

Bounds are obtained for the energy of a charged particle moving in an alternating axisymmetric magnetic field in both the relativistic and nonrelativistic cases. The estimates are considered in detail for special cases of the motion of a charged particle in a homogeneous alternating magnetic field. (auth)

3739 ELECTROMAGNETIC INTERACTION OF A MASSIVE SPIN ONE PARTICLE: SOME EQUIVALENCE THEOREMS AND REMARKS. Jenkins, J. D. (Univ. of Durham, Eng.). J. Phys., A (London); 5: No. 10, 1461-72(Oct 1972).

The minimal electromagnetic interaction is introduced into various free, quantum mechanical spin-one formalisms, and it is found that the resulting theories are essentially equivalent. This situation does not prevail when, in addition, magnetic dipole or electric quadrupole interactions are considered. For such simple interactions in one formalism are found, in general, to be equivalent to structurally more complicated interactions in the other formalisms considered. Some known results on the acausal propagation of solutions of wave equations for a classical spin-one particle in an external electromagnetic field are, with the aid of the above equivalence theorems, which are easily seen to apply to the classical case also, extended to include all the spin-one formalisms considered. (auth)

3740 DISCRETE STRUCTURE IN VELOCITY SPACE. Iwai, Junsuke (Waseda Univ., Tokyo); Mori, Kenju; Nakamura, Hiroshi. Progr. Theor. Phys. (Kyoto); 48: No. 3, 1054-5(Sep 1972).

A theory was previously proposed establishing a relation between the observed enhancements in the distribution of the longitudinal Lorentz angles for the meson clusters emitted from cosmic jet interactions and the simplest three-dimensional integral Lorentz transformation. A specific minimum velocity $v = (\sqrt{8}/3)c$ was found. It is pointed out that there is a possible existence of another specific velocity $(\sqrt{3}/2)c$. (J.F.P.)

3741 DEEP INELASTIC e–p SCATTERING AND SINGLE PARTICLE DISTRIBUTIONS INITIATED BY THE VIRTUAL PHOTON IN THE LATTICE DUAL RESONANCE MODEL: HAMILTONIAN FORMALISM. Biyajima, Minoru (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 48: No. 3, 1005-23(Sep 1972).

In the lattice dual resonance model, the Ward-Takahashi-like identity for the photon vertex is derived. The validity of the statistical approximation in deep inelastic e–p scattering is shown. Employing the above-mentioned gauge invariant formulation and the statistical approximation, one can analyze the single-particle distribution initiated by (the real- and) virtual photon in the process $\gamma(A) + B \rightarrow X(C) +$ anything. In this lattice dual resonance model, explicit forms for the single particle distribution functions are obtained. The three kinds of structure functions exhibit both Feynman and Bjorken scaling properties in the limiting fragmentation region, the universal shrinking cutoff in the transverse momentum of the form $\exp(-4\alpha'(p_T^2 + m_C^2)(1 + q_A^2/xs)|_{x\to 0})$ in the central region and the vanishing triple-Regge behavior in the kinematical boundary region, respectively. The quantity x is the Feynman parameter. This shrinking transverse momentum distribution should be confirmed by experiments to test the validity of this model. Furthermore, this vanishing triple-Regge behavior is expected in near future experiments. It is also predicted that the Feynman scaling and the Bjorken scaling functions are almost factorizable. (auth)

3742 SCREENING EFFECTS IN PAIR PRODUCTION AT INTERMEDIATE AND HIGH ENERGIES. Borie, E. (Univ., Maniz); Arenhoevel, H. Z. Phys.; 255: No. 5, 459-63(1972).

The effect of screening in atomic field pair production is calculated in the Born approximation without an approximation as to energy or angle and compared with the results of previous calculations based on the high energy approximation. The difference between the two calculations is comparable to the errors in recent experiments. The effect of nuclear excitation on the total pair production cross section is also investigated, but is found to be extremely small. (auth)

3743 INCLUSIVE PHOTON SPECTRA AND HIGH-ENERGY MULTIPLICITIES. Cahn, R. N. (Stanford Univ., Calif.). Phys. Rev. Lett.; 29: No. 21, 1481-4(20 Nov 1972).

The consequences of Feynman scaling are examined for photon spectra at $x = 0$ arising from π^0 decays. A consistency condition on the photon distribution is obtained. The low-transverse-momentum region is examined in detail and the contribution of bremsstrahlung computed to be $(k/\sigma_{tot})d\sigma/d^3k = (\alpha/\pi^2 k_1^2)\langle(\Delta Q_R)^2\rangle$, where ΔQ_R is the final right-moving charge minus the initial right-moving charge. This relation, together with the consistency condition, provides a new means of obtaining pertinent multiplicity information at very high energies. (auth)

3744 SIXTH-ORDER RADIATIVE CORRECTIONS TO THE ELECTRON MAGNETIC MOMENT. Kinoshita, T.; Cvitanovic, P. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett.; 29: No. 22, 1534-7(27 Nov 1972).

The contribution of fifty Feynman diagrams of the order α^3 to the electron magnetic moment was calculated. The result, $(1.02 \pm 0.04)(\alpha/\pi)^3$, agrees with the result of Levine and Wright, and is about 5 times more accurate. Together with the contribution from the rest of the α^3 diagrams calculated previously, the complete theoretical prediction for the electron anomaly up to the order α^3 is $\alpha/2\pi - 0.328\,48(\alpha/\pi)^2 + (1.29 \pm 0.06)(\alpha/\pi)^3$, in good agreement with the latest experimental result. (auth)

3745 ELECTROMAGNETIC EFFECTS ON HIGH-ENERGY CROSS-SECTIONS. Scott, W. G. (Cambridge Univ., Eng.). Lett. Nuovo Cim.; 5: No. 10, 711-17(4 Nov 1972).

Models with simple violation of Pomeranchuk theorem and saturation of the Froissart bound in an approximate phenomenological sense are discussed. The interference between these models and the electromagnetic amplitude in the differential cross sections in the near forward direction is examined. The possibility that the observed difference in the pion–nucleon total cross sections may be electromagnetic in origin is discussed. It is suggested that electromagnetic corrections to the total cross section are small. (J.F.P.)

3746 LOOP DIAGRAM IN KIKKAWA-SATO MODEL AND SCALING IN $e^+e^- \rightarrow e^+e^-$ + HADRONS. Roy, T.; Chowdhury, A. R. (Jadavpur Univ., Calcutta). Lett. Nuovo Cim.; 5: No. 10, 707-10 (4 Nov 1972).

The loop diagram for $\gamma + \gamma \rightarrow \gamma + \gamma$ is calculated in the Kikkawa–Sato model to obtain information about the structure functions

W_i (i = 1, ..., 8) in $e^+ + e^- \rightarrow e^+ + e^-$ + hadrons interactions. Explicit scaling behavior is obtained in the Bjorken limit. (J.F.P.)

3747 INTERNAL SYMMETRIES AND HAN–NAMBU PARTONS. Chang, T. H.; Choudhury, D. K. (Univ. of Oxford). Lett. Nuovo Cim.; 5: No. 10, 727-30(4 Nov 1972).

The predictions of the ratio $F_1^{\gamma n}(x)/F_1^{\gamma p}(x)$ in all different parton models are presented by invoking different internal symmetries in the deep inelastic region. The structure functions for the process e + N → e + anything interactions are discussed. (J.F.P.)

3748 COMMENT ON THE SATURATION OF THE ADLER INELASTIC LEPTON–HADRON SUM RULE IN THE FRAMEWORK OF A QUARK–PARTON MODEL. Pestieau, J. (Instituto Politecnico Nacional, Mexico City); Salazar, J. J. Lett. Nuovo Cim.; 5: No. 10, 735-8(4 Nov 1972).

It was previously shown that the Adler sum rule for deep inelastic electroproduction could only be satisfied if one has slow convergence and/or bizarre behavior of $F_2^{\nu p}/F_2^{\bar{\nu}p}$. It is shown that this bizarre behavior comes out naturally from a rather general type of quark–parton model. (J.F.P.)

3749 NOTE ON THE MINIMAL ELECTROMAGNETIC INTERACTION OF SPIN-TWO PARTICLES. Choudhury, S. R. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 5: No. 10, 698-700(4 Nov 1972).

It was previously found that for spin-two particles interacting with the electromagnetic field via the minimal interaction the number of degrees of freedom increases to six, which is one more than in the free-field case. It is shown that there exist spin-two Lagrangians which yield equations of motion that are stable as far as the number of degrees of freedom is concerned when the electromagnetic interaction is introduced via the minimal replacement. (J.F.P.)

Weak

Refer also to abstracts 2552, 3370, 3873, and 3922.

3750 (DESY–72/48) SYMMETRY PRINCIPLES AND CONSTRAINTS ON DEEP INELASTIC STRUCTURE FUNCTIONS. Chaichian, M.; Pallua, S. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1972. 37p. Dep. NTIS (U. S. Sales Only).

It is shown that isospin invariance for hadron states and the usual SU(2) transformation properties of electromagnetic and weak currents (CVC hypothesis) impose strong restrictions on the weak structure functions in terms of the electromagnetic ones. Among others, the inequalities $(F_p^{\bar{\nu}} + F_p^{\nu})/(F_p^{\gamma} + F_n^{\gamma}) \leq 4$ and $-\infty \leq 1/2\,(F_p^{\nu} - F_p^{\nu}) - 3F_p^{\gamma} \leq 3/2\,F_n^{\gamma}$ are obtained. Furthermore, a quite restrictive scheme is obtained if one adds the following assumptions: electromagnetic and weak currents are members of a SU(3) octet in the usual sense, absence of t-channel exotics, and currents transform as nonets under U(3). It is shown that this scheme gives results which are "very close" to the SU(2) quark parton-light cone models. In particular, one obtains $1/4 \leq F_p^{\gamma}/F_n^{\gamma} \leq 4$, $[(F_p^{\bar{\nu}} + F_p^{\nu})/(F_p^{\gamma} + F_n^{\gamma})] \leq 18/5$, and $-6\ 11F_n^{\gamma} \sim (-12 + 9\sqrt{21/F})F_n^{\gamma} \leq 1/2\,(F_p^{\nu} - F_p^{\nu}) - 3\,F_p^{\gamma} \leq 3/2\,F_n^{\gamma}$. The consequences of adding the SU(3) symmetry of hadron states are also investigated. All the statements which involve weak structure functions require as an additional assumption equality of vector and axial-vector contributions to the scattering amplitudes. (auth)

3751 CURRENT ALGEBRA AND PCAC. Treiman, S. B. pp 3-96 of Lectures on Current Algebra and Its Applications. Treiman, S. B. Princeton, N. J.; Princeton Univ. Press (1972).

The lecture on current algebra and PCAC covers the following topics: the physical currents, current commutation relations, PCAC, current algebra methods, applications of current algebra, the Adler–Weisberger formula and generalizations, semileptonic decay processes, and nonleptonic decays. (L.B.S.)

3752 LEPTONIC DECAYS OF HADRONS. Chounet, L.-M. (Laboratoire de l'Accelerateur Lineaire, Orsay, France); Gaillard, J.-M.; Gaillard, M. K. Phys. Rep.; 4C: No. 5, 199-323 (1972).

The theory of semi-leptonic weak interactions is reviewed and confronted with present experimental data. The theoretical points emphasized are the basic tenets of the Cabibbo theory, the algebra of currents, and the relevance of strong interaction symmetries to the weak semi-leptonic amplitudes. The experimental data are discussed in detail, and future lines of investigation, necessary for testing detailed theoretical predictions and for resolving outstanding questions, are indicated. (auth)

3753 HISTORY OF WEAK INTERACTIONS. Lee, T. D. (Columbia Univ., New York). pp 828-40 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

The history of weak interactions is reviewed, covering the early history, transition period, and the present status. (L.B.S.)

3754 FOUR-COMPONENT HYPERMASS EQUATION POSSIBLY APPLYING TO UNSTABLE NEUTRINOS. Edmonds, J. D. Jr. (Ames Research Center, Moffett Field, Calif.). Lett. Nuovo Cim.; 5: No. 7, 572-4(14 Oct 1972).

A wave equation which comes out of the quaternion mass generalization is discussed. It described a particle with four internal parts, spin ½, hypermass, and complex energy. It is a direct generalization of the usual neutrino equation, satisfies a Klein–Gordon equation, and has a conserved current. For ordinary mass it gives a spin-½ tachyon equation. (J.F.P.)

3755 POLARIZATION EFFECTS IN νe- AND $\bar{\nu} e$-SCATTERING AND ELECTROMAGNETIC PROPERTIES OF NEUTRINOS. Rekalo, A. P. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 9, 1428-30(Sep 1972). (In Russian).

Processes of elastic νe- and $\bar{\nu} e$-scattering are considered taking into account the weak interaction transferred by a charged vector boson and the electromagnetic interaction of a neutrino with an electron. The electromagnetic vertex of the neutrino was chosen in the most general form, with considering possible violation C- and T-invariance. The differential scattering cross sections of a neutrino by polarized electrons are obtained taking into account polarization of the scattered electron. (auth)

3756 MUON CAPTURE IN DEUTERIUM. Pascual, P.; Tarrach, R.; Vidal, F. (Univ. of Barcelona). Nuovo Cim.; 12A: No. 1, 241-8(1 Nov 1972).

The muon capture in deuterium is studied by means of the impulse approximation with relativistic corrections. The deuteron is described by means of the S- and D-wave. (auth)

3757 NEUTRAL-CURRENT EFFECTS IN A CLASS OF GAUGE FIELD THEORIES. Pais, A. (Rockefeller Univ., New York); Treiman, S. B. Phys. Rev., D; 6: No. 9, 2700-3 (1 Nov 1972).

Neutral-current couplings constitute a distinctive feature of certain models of weak interactions based on the idea of broken gauge symmetry. The observational implications for semileptonic processes are discussed; in particular, the relations among the inclusive ($\Delta S = 0$) reactions $\nu + N \rightarrow \nu + X$, $\nu + N \rightarrow \mu + X$, e + N → e + X. For I = 0 targets, and with no further dynamical assumptions, the theoretical bound $\sigma^{(\nu \rightarrow \nu)}/\sigma^{(\nu \rightarrow \mu)} \gtrsim 0.14$ is found for neutrino energies above a few GeV. Additional theoretical input increases this lower bound to 0.24. (auth)

3758 DUAL AMPLITUDES AND SCALING IN INELASTIC LEPTON–HADRON COLLISIONS. Roy, T.; Chowdhury, A. R. (Jadavpur Univ., Calcutta). Phys. Rev., D; 6: No. 9, 2649-51 (1 Nov 1972).

Scaling behaviors of the structure functions F_1 and F_2 in high-energy inelastic lepton–hadron collisions are obtained with the help of the off-mass-shell scattering amplitude constructed from five-point Veneziano functions. The method reveals the drawback of the perturbation approach and suggests a fermionic character of the partons. A quark model is seen to be favored by the results. Unlike the existing theoretical attempts, the over-all results of the present formulation seem to be supported by experimental data. (auth)

3759 MODEL OF LEPTONS. Tennakone, Kirthi; Pakvasa, Sandip (Univ. of Hawaii, Honolulu). Phys. Rev., D; 6: No. 9, 2494-2512(1 Nov 1972).

A new model of leptons based on discrete scale transformations is proposed. It is shown that this model predicts a lepton mass spectrum consisting of an infinite series of electronlike and muonlike particles whose masses and charges are given by $m_n = m_e \rho^n$ ($\rho = m_\mu/m_e$) $Q = \frac{1}{2}e(1 + n/|n|)$. Particles with n positive are charged, those with n negative neutral. Possible weak coupling schemes of charged and neutral leptons are considered. The lepton with n = 2 is a heavy electron at 22 GeV. Decay modes and production mechanisms of this particle are discussed. It is shown that, apart from high production cross sections needed to fit experimental data, some of the recently observed anomalies in cosmic-ray muons can be effects due to heavy leptons predicted by this model. (auth)

3760 FERMION LOOPS AND THE $K_2^0 \rightarrow \mu^+\mu^-$ PUZZLE. Amado, R. D. (Univ. of Pennsylvania, Philadelphia); Noble, J. V. Phys. Rev., D; 6: No. 9, 2696-7(1 Nov 1972).

It is shown that the fermion-loop model for $K_2^0 \rightarrow \gamma\gamma$ recently proposed by Rockmore and Wong makes the puzzle of the missing $K_2^0 \rightarrow \mu^+\mu^-$ rate some four times worse, and that the difficulty cannot be removed by the usual CP-violation hypothesis. (auth)

3761 HIGHER-ORDER TERMS IN THE V–A THEORY OF THE WEAK INTERACTIONS AND LEPTONIC SCATTERING PROCESSES AT HIGH ENERGIES. Maiella, G.; Lopez-Cepero, A. B. (Univ. of Texas, Austin). Nuovo Cim.; 12A: No. 1, 279-95(1 Nov 1972).

An attempt is made to evaluate higher-order corrections for the V−A theory of the weak interactions. Instead of the customary cut-off method, a perturbative expansion at the second order in G_μ is employed. Then one computes the second-order Feynman diagrams introducing indetermined subtraction constants to make the matrix elements finite. This analysis is applied to the leptonic scattering process at high energies. It is shown that their cross sections can be parametrized in terms of one unknown constant b_1, under the assumption that $b_1 \gg 1$. If b_1 is sufficiently large, i.e. $b_1 \simeq 10^4$, the second-order corrections to the first-order leptonic processes and the cross sections of the second-order processes are sizable and could be detected at NAL. Finally the consequences of the lack of the diagonal interaction in the V−A leptonic Lagrangian are discussed. (auth)

3762 QUESTIONS PERTAINING TO CHARGE DEPENDENCE OF RADIATIVE CORRECTIONS TO SUPERALLOWED FERMI TRANSITIONS. Beg, M. A. B. (Rockefeller Univ., New York); Bernstein, J.; Sirlin, A. Phys. Rev., D; 6: No. 9, 2597-2606(1 Nov 1972).

The problem posed by the near equality of the ft values for the nine $0^P \rightarrow 0^P$ (P = + or −) superallowed Fermi transitions is considered. So long as one is oblivious to radiative effects, this near equality of ft values may be (as, indeed, it has been) regarded as a triumph of the CVC (conserved-vector-current) hypothesis. However, if one takes note of the fact that CVC, which guarantees the equality of the "bare" ft values, is broken by electromagnetism and that the charge of the decaying nuclei varies from Z = 1 (for π^+) to Z = 27 (for ^{54}Co), the relationship between CVC and the physical ft values becomes obscure; CVC can be upheld only if one can establish that the renormalization effects are small. In a previous contribution a combination of general theorems and model-dependent arguments was used to show that, in the limit of vanishing lepton momenta, Z-dependent renormalization effects arise only in order $Z^2\alpha^2$ (3.9% for ^{54}Co). A fuller explanation is given of the aforementioned theorems as well as amplified and improved proofs. Also, topics not treated in our earlier work (corrections for finite lepton momenta, effects of real photon emission, etc.) are discussed and the model-dependent part of the argument is reviewed. (auth)

3763 LEE–SUGAWARA RELATION FOR NONLEPTONIC P-WAVE DECAYS OF HYPERONS. Naito, Seichi (Osaka City Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 1056-7(Sep 1972).

It is shown in the chiral SU(3) × SU(3) limit that the Lee–Sugawara relation is satisfied by P-wave decay amplitudes due to the parity conserving part of a previously derived effective strangeness-changing weak Hamiltonian, provided that initial and final baryons belong to the (3,3*) + (3*,3) representation of SU(3) × SU(3). (J.F.P.)

3764 GENERALIZED SIMILARITY RELATION AND TRILINEAR MATRIX ELEMENTS. Katuya, Mituaki (Hokkaido Univ., Sapporo). Progr. Theor. Phys. (Kyoto); 48: No. 3, 927-38(Sep 1972).

A scheme is proposed in which the matrix elements for pseudoscalar meson production in neutrino-nucleon collisions and for $B_8 \rightarrow B_8 + P_8 + e^- + \tilde{\nu}_e$ decays can be described. This scheme is based on a generalized "similarity" assumption. In this scheme one can obtain some sum rules for pseudoscalar meson production in neutrino-nucleon collisions and for spontaneous decays, $B_8 \rightarrow B_8 + P_8 + e^- + \tilde{\nu}_e$. Some of the results are different from those obtained from a theory proposed by Ogawa. From the viewpoint of the universality of weak interactions, it is predicted that $\Gamma(\Sigma^+ \rightarrow p\pi^+e^-\tilde{\nu}_e) \approx \frac{1}{3}\Gamma(\Sigma^- \rightarrow p\pi^-e^-\tilde{\nu}_e) \approx 0.5 \times 10^{-17}$ MeV, as a possible experimental test of the theory. (auth)

Strong (General)

3765 DUAL-MODEL ANALYSIS OF SINGLE-PARTICLE PRODUCTION AT INTERMEDIATE ENERGIES. Kang, Kyungsik; Shen, Pu (Brown Univ., Providence). Phys. Rev. Lett.; 29: No. 18, 1283-7(30 Oct 1972).

A systematic numerical analysis of the single-particle distribution is presented in a dual-resonance model at energies presently accessible. The results are in reasonably good agreement with experiments. In addition, a criterion for the scaling limit in energy is suggested, and the pion production rate is predicted to be much slower in the pionization limit than at intermediate energies. (auth)

3766 QUASI-POTENTIAL APPROACH IN THEORY OF HIGH-ENERGY HADRON SCATTERING. Il'in, V. V. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 8, 1319-25(Aug 1972). (In Russian).

The high energy hadron scattering amplitude is studied on the basis of the quasi-potential approach with a crossing symmetric quasi-potential. The eikonal approximation is also used. The total cross section obtained in this way is compared with the experimental data on pp-scattering. (auth)

3767 HADRONIC ATOMS. Kolybasov, V. M. Usp. Fiz. Nauk; 107: No. 3, 438-41(Jul 1972). (In Russian).

This short review article was prepared by V. M. Kolybasov as a supplement to his translation of "Pionic Atoms" by G. Backenstoss (A., Rev. Nucl. Sci., 20: 467(1970)), printed on pages 405–438 of Uspekhi Phys. Nauk. K^--mesonic, antiprotonic, and Σ^--hyperonic atoms were observed. Experimental studies of K-mesonic atoms from Z = 3 to 92 are briefly considered. Transitions observed in K-mesonic atoms differ from those expected from theory, and this discrepancy is discussed on the basis of one vs. many nucleon capture of K-mesons, and the dependence of the amplitude of KN-interaction on the mass of the system "K-meson–nucleon." The possibility of determining the electromagnetic dimensions of hadrons and their polarity using hadronic atoms is examined. (14 references) (K.S.W.)

3768 KINEMATICAL CUT-OFF FOR THERMODYNAMIC SINGLE-PARTICLE SPECTRA USING A PHASE-SPACE METHOD. Hagedorn, R. (CERN, Geneva); Ranft, J. Nucl. Phys., B48: No. 1, 191-204(1972).

Thermodynamic momentum spectra do not obey energy conservation; therefore a kinematical cut-off procedure has to be added. A method is described which replaces the thermodynamic formulas by phase space near the kinematical limits. This method is actually used in calculating the thermodynamic single-particle spectra. (auth)

3769 INCLUSIVE SINGLE PARTICLE SPECTRA AND THE STRONG THERMODYNAMIC BOOTSTRAP SOLUTION. Hagedorn, R. (CERN, Geneva); Ranft, J. Nucl. Phys., B48: No. 1, 157-90(1972).

The thermodynamical model was based so far on a bootstrap condition requiring asymptotic equality of the logarithms of the hadronic mass spectrum and of the level density of the fireballs, resulting in a family of exponential solutions, of which one was chosen on the basis of plausibility arguments. Through the work of Frautschi, Frautschi and Hamer and of Nahm, the bootstrap condition has been sharpened and now leads to a unique asymptotic solution slightly different from the one chosen before. The consequences of using this strong bootstrap solution in the thermodynamical model for particle production are discussed. If all other assumptions remain unmodified, the following changes occur: the decay chain of fireballs becomes approximately manageable and is included in the analysis; scaling and limiting fragmentation hold exactly; the rapidity distribution has a central plateau; and multiplicities grow logarithmically. Numerical differences against the old version are, however, small even at ISR energies, where the predictions are compared with experimental data. (auth)

3770 GRAND PARTITION FUNCTION IN THE UNCORRELATED JET MODEL. de Groot, E. H. (Oxford Univ.). Nucl. Phys., B48: No. 1, 295-317(1972).

By calculating the grand partition function it is shown that all calculations within the uncorrelated jet model can be performed analytically. The general case, where the one-particle distribution function depends on the transverse momentum as well as on the scaling variable, is treated. As the momentum sum rules are identically obeyed in this model this can be of use in exploring the contents of these sum rules. As an example the inclusive n-particle distribution functions are calculated. Also the effects of meson production on the elastic scattering via the unitarity relation is discussed. (auth)

3771 CURRENTS AND GREEN'S FUNCTIONS FOR DUAL MODELS. II. OFF-SHELL DUAL AMPLITUDES. Cremmer, E.; Scherk, J. (CERN, Geneva). Nucl. Phys., B48: No. 1, 29-77(1972).

Off-shell dual amplitudes are constructed in a way consistent with factorization in the space of harmonic oscillators of the conventional model. They are shown to have only correctly located singularities. The use of domain variational theory on Riemann surfaces is of crucial importance to prove this result. The case of currents with quantum numbers is also discussed. (auth)

3772 UNSTABLE COMPOSITE PARTICLES. van Der Merwe, P. du T. (Atomic Energy Board, Pretoria). Nucl. Phys., B48: No. 1, 125-40(1972).

A functional derivative formulation of relativistic three-particle equations as a framework for unstable composite particles is developed. (auth)

3773 EXOTIC ATOMS. Wiegand, Clyde E. Sci. Amer.: 227: No. 5, 102-8; 10(Nov 1972).

Research on exotic atoms is summarized including properties of the hydrogen atom, exotic atoms with mesons, pionic and muonic atoms, kaon and sigma hyperon exotic atoms, study of nuclear surface using kaonic atoms, antiprotonic atoms, and the possibility of xi and omega exotic atoms. (J.F.P.)

3774 EIKONAL REPRESENTATION OF SCATTERING AMPLITUDE INCLUDING THE VIRTUAL VENEZIANO BLOCKS. Barbashov, B. M.; Nesterenko, V. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Teor. Mat. Fiz.; 13: No. 1, 83-7(Oct 1972). (In Russian).

The Regge eikonal representation is deduced by means of the functional integration method for a sum of diagrams of the ladder type describing the high energy scattering of scalar particles. The main point in the model is the exchange of the virtual blocks which are described by the Veneziano amplitudes, between scattering particles. (auth)

3775 POSSIBLE FAILURE OF THE POMERANCHUK THEOREM, SHRINKAGE OF THE FORWARD ELASTIC PEAK AND OSCILLATIONS. Casella, R. C. (National Bureau of Standards, Washington, D. C.). pp 518-25 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

The breakdown of the Pomeranchuk theorem for extrapolated total cross sections $\sigma(s)$ is discussed and is shown to lead to a natural expression for the $(\ln s)^2$ shrinkage of the forward elastic peak. It is also shown outside the context of the Regge framework that the elastic differential cross section oscillates wildly with t. (L.B.S.)

3776 WHAT IS THE NUCLEON MADE OF? Weisskopf, V. F. (Massachusetts Inst. of Tech., Cambridge). pp 768-89 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

The substructure of the hadron is discussed within the framework of certain facts which are more or less established experimentally and which can be explained by a simple parton picture. It is shown that certain important qualitative relations, such as the high-energy behavior of the total cross sections and exchange cross sections, the multiplicity of pions at high-energy hadron collisions, and certain features of the deep-inelastic electron scattering of protons and neutrons, can be explained by a simple quark model of the hadron. In this picture the nucleon consists of three quarks and the meson of a quark–antiquark pair. (L.B.S.)

3777 POSSIBLE BOOTSTRAP ORIGIN OF THERMODYNAMIC INCLUSIVE SPECTRA. Harte, John; Rawls, J. M.; Yen, H. C. (Yale Univ., New Haven). Phys. Rev., D; 6: No. 9, 2522-30(1 Nov 1972).

A bootstrap approach is shown to reproduce a number of the results of hadronic statistical thermodynamics without the use of thermodynamical assumptions; in particular, a possible dynamical origin for the crucial constant-"temperature" Boltzmann factor in single-particle distributions is demonstrated. In this model, a fireball decays sequentially, each vertex in the decay chain being described by an asymptotic vertex function derived from a bootstrap theory of infinitely composite particles. When combined with a diffractive model for fireball production, the bootstrap description leads to good agreement with the qualitative features of inclusive reaction data. (auth)

3778 LEVEL STRUCTURE OF BARYONS AND THE QUARK-QUARK INTERACTION. Chen-Tsai, C. T.; Chu, S. I.; Lee, T. Y. (National Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., D; 6: No. 9, 2451-9(1 Nov 1972).

The mass spectrum of the baryons in the $(56,0^+)$ and $(70,1^-)$ is analyzed within a formalism in which the 15 independent matrix elements of the two-body quark potential are taken to be parameters for a least-squares calculation. The evaluated parameters are used to analyze an assumed phenomenological two-body quark potential, consisting of superstrong, SU(6)-breaking, SU(3)-breaking, spin-orbit, and tensor terms. The structure of the baryonic levels is studied by examining the contributions to mass values from each potential term. (auth)

3779 METHOD TO DISTINGUISH BETWEEN MULTIPARTICLE PRODUCTION MECHANISMS. Dar, A.; Vary, J. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., D; 6: No. 9, 2412-17(1 Nov 1972).

Multiparticle production in particle-nucleus collisions at high energies is shown to provide a sensitive test for mechanisms of multiparticle production in particle-nucleon collisions at high energies. (auth)

3780 MULTIPARTICLE SPECTRA IN SIMPLE THEORETICAL MODELS: A CLUSTER-DECOMPOSITION ANALYSIS. Campbell, D. K. (Univ. of Illinois, Urbana). Phys. Rev., D; 6: No. 9, 2658-89(1 Nov 1972).

A detailed investigation of inclusive and exclusive multiparticle spectra in several simple models of high-energy hadronic interactions is presented. To clarify the origins of particular structure in these spectra the study is divided into two sections. First, models designed to isolate the features arising from kinematic constraints are discussed. Specifically, both pure longitudinal phase space and a longitudinal phase space modified to produce a "leading-particle" effect are treated. In the second section examples of specific dynamical models are considered. Here the simplified Chew–Pignotti model, in both the strong-ordered and general versions, and a "φ^3-type" multiperipheral model are investigated. The analysis is based on a cluster-decomposition approach analogous to that used in statistical mechanics. In particular, a set of "cluster-function sum rules" is applied to relate the correlations found in inclusive spectra to those observed in exclusive processes. Within the context of the models, it is established that these sum rules provide both an attractive qualitative picture of correlations in multiparticle spectra and a useful quantitative framework in which to calculate these correlations. A discussion of the possible extensions of these cluster techniques to phenomenological analyses of high-energy interactions is given. (auth)

3781 BOOTSTRAP MODEL OF INCLUSIVE REACTIONS. Finkelstein, J.; Peccei, R. D. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 9, 2606-17(1 Nov 1972).

A model in which multiparticle processes are envisaged as occurring via the formation of a fireball and a leading particle is studied. A bootstrap condition is imposed on the fireball decay distribution by demanding that it be the same, in its rest system, as the over-all distribution in the c.m. system. This leads to a set of integral equations for both single-particle and multiparticle inclusive distributions. These equations are examined in the scaling limit, it is shown that the multiplicity of particles grows logarithmically with energy and that the multiparticle distributions factorize for particles traveling in opposite directions, and a bound on the size of the two-particle distribution function is obtained. If Regge constraints are imposed, it is shown that the model predicts that the scaling limit for the single-particle distribution function, in the central region, is approached from below. Furthermore, many of the features of a Mueller analysis are clearly exhibited by the model. Various properties of the model are illustrated by means of two examples, one of which is in qualitative agreement with experiment. (auth)

3782 INTERRELATION BETWEEN EXCLUSIVE AND INCLUSIVE REACTIONS. II. INCLUSIVE REACTIONS AND URBARYON REARRANGEMENT DIAGRAMS. Noda, Hujio; Kinoshita, Kisei (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto): 48: No. 3, 877-87(Sep 1972).

The interrelation between exclusive and inclusive reactions is investigated from the standpoint of the urbaryon rearrangement diagram. A reduction rule of urbaryon lines is proposed to analyze the unitarity relation between exclusive and inclusive reactions. The selection rule for urbaryon rearrangement diagrams to characterize the forward absorptive amplitude, which contributes to the N-particle inclusive spectrum through the generalized optical theorem, is derived from the reduction rule. The total cross section and single-particle distribution are discussed in detail. This approach does not rest on the Harari-Freund hypothesis nor suffer from the baryon problem in duality. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 3611 and 3666.

3783 (CALT-68-354) PHENOMENOLOGICAL MODEL FOR DIFFRACTIVE EXCITATION OF HADRON RESONANCES. Ravndal, F. (California Inst. of Tech., Pasadena). 1972. Contract AT(11-1)-68. 37p. Dep. NTIS.

In order to describe diffractive excitation of hadrons, a vector–vector form for the imaginary amplitude is proposed. The vector transition operator is related to the ordinary vector current. This description gives approximate s-channel helicity conservation in elastic πN-scattering and a differential cross section for elastic NN-scattering proportional to the fourth power of the magnetic form factor of the nucleon. All inelastic cross sections for excitation of hadron resonances should dip in the very near forward direction. Calculating the matrix elements of the diffractive transition operator in a relativistic quark model with essentially no free parameters, one obtains quantitative results in good agreement with experiment for most nucleon and pion resonances. (auth)

3784 K_S^0 REGENERATION AMPLITUDE IN CARBON PREDICTED FROM MEASURED $K^\pm$ FORWARD SCATTERING AMPLITUDES. Gobbi, B.; Hakel, W.; Rosen, J. L.; Shapiro, S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 29: No. 18, 1281-3(30 Oct 1972).

The amplitude of K_S^0 regeneration in carbon is predicted by use of $f_{K^+}(0)$ and $f_{K^-}(0)$ extracted from $K^\pm$ elastic scattering by carbon at momenta of 1.68, 2.01, and 2.26 GeV/c. (auth)

3785 CHIRAL INVARIANCE AND EFFECTIVE RANGE EXPANSION FOR PION–PION SCATTERING. Lehmann, H. (Univ., Hamburg). Phys. Lett.; 41B: No. 4, 529-32(16 Oct 1972).

The well-known low-energy theorems for the scattering of massless pions are extended to terms which are of fourth order in the pion momenta. (auth)

3786 COMMENT ON NUCLEON–ANTINUCLEON ANNIHILATION AND THE POSSIBILITY TO DETERMINE THE SPIN FOR RESONANCES IN THE DIRECT CHANNEL OF THIS PROCESS. Brink, L. (Chalmers Tekniska Hoegskola, Goteborg). Phys. Scr.; 5: No. 3, 117-18(1972).

The process of nucleon-antinucleon annihilation into pions is considered from the viewpoint of duality. The possibility of measuring the spin of an intermediate resonance is discussed. The method proposed is an extension to an arbitrary number of particles in the final state of the fact in $2 \to 2$ particle scattering that the distribution in the polar angle, θ, is limited by $\cos^J\theta$, where J is the total angular momentum involved in the process. A method is devised to take full account of the statistics. (auth) (Sweden)

3787 ABFST MODEL AND HIGH ENERGY SCATTERING. Halliday, I. G.; Islam, S.; Parry, G. (Imperial Coll. of Science and Tech., London). J. Phys., A (London); 5: No. 6, 853-8 (Jun 1972).

The exact form of the ABFST integral equation is studied and treated as an equation for the irreducible kernel, given the total $\pi\pi$ cross section. The usual identification of the irreducible kernel with the elastic cross section is seen to be highly unlikely. The result depends violently on the off-mass-shell behavior of the $\pi\pi$ amplitude. In general the irreducible kernel is not even positive definite. (auth)

3788 SPECTRAL-FUNCTION SUM RULES AND $\omega-\phi$ MIXING. Kenny, B. G. (Australian National Univ., Canberra). Phys. Rev., D; 6: No. 9, 2617-24(1 Nov 1972).

A calculation of the $\omega-\phi$ mixing problem is performed, using the spectral-function sum rules of Weinberg, which is more comprehensive than previous similar calculations. In conjunction with the first sum rule asymptotic nonet symmetry is assumed. The second sum rule modified by corrections estimated using the Gell–Mann, Oakes, and Renner model of the SU(3) ⊗ SU(3)-breaking strong interactions is used. The predictions of the model are in good agreement with experiment where accurate experimental data are available. It is indicated how it is possible to reconcile previous competing theories within the more comprehensive framework of our model. (auth)

3789 SOME NEW ISOSPIN BOUNDS IN MULTIPION PRODUCTION. Llewellyn-Smith, C. H. (Stanford Univ., Calif.); Pais, A. Phys. Rev., D; 6: No. 9, 2625-36(1 Nov 1972).

Reactions are considered in which N pions are produced, subject to the constraint that the over-all isospin of the $N\pi$ system does not exceed the value one. For any N, bounds are given on the ratio of neutral to charged pions. From these N-dependent bounds, "enveloping bounds," valid for all N are obtained. The proofs rest on an earlier remark that all of the (generally many) $N\pi$ states with a given mixed symmetry (and with $I \leq 1$) have the same branching ratios for generating various charge partitions. (auth)

3790 $\bar{p}p$ ANNIHILATION IN THE MULTIPERIPHERAL REGGE MODEL. Goldberg, Hyman (Northeastern Univ., Boston). Phys. Rev., D; 6: No. 9, 2542-5(1 Nov 1972).

Using the simple multi-Regge model of Chew and Pignotti, an acceptable fit to the bulk of $\bar{p}p$ annihilation data is obtained. The parameters of the fit are consistent with $\sigma_{\bar{p}p}^{tot} - \sigma_{pp}^{tot} \propto s^{\alpha_\omega(0)-1}$. (auth)

3791 COMPULSORY RESONANCE FORMATION. Rosner, J. L. (Univ. of Minnesota, Minneapolis). Phys. Rev., D; 6: No. 9, 2717-20(1 Nov 1972).

It is noted that if two mesons are allowed by the quark model to resonate, they do so for $p^* \leq p_0^{MM} \cong 350$ MeV/c, where p^* is the c.m. momentum. The corresponding value for meson–baryon systems is $p_0^{MB} \cong 250$ MeV/c, suggesting (in an optical picture) that the baryon is indeed bigger than the meson. Crucial tests of the rule are provided by exotic baryon-anti-baryon systems, for which one expects $p_0^{BB} \cong 200$ MeV/c, and by other specific two-body modes which are predicted to resonate not far above threshold. (auth)

3792 $N\bar{N}$ ANNIHILATION AT REST IN THE STATISTICAL BOOTSTRAP MODEL. Hamer, C. J. (California Inst. of Tech., Pasadena). Contract AT(911-1)-68. Nuovo Cim.; 12A: No. 1, 162-84(1 Nov 1972).

Fermi's statistical model of high-energy hadron collisions is modified to take full account of resonance production, using the statistical bootstrap model of Hagedorn and Frautschi. Comparisons are made with experiments on $N\bar{N}$ annihilations at rest, the most favorable testing ground available. After adjustment of the single parameter R (the "interaction radius"), it is found that the multiplicity distributions and branching ratios are generally well fitted, except that events in which $K\bar{K}$ pairs are emitted occur less frequently than predicted, indicating that these channels are dynamically suppressed. The expected size of statistical fluctuations is discussed, as a basis for judging the results. The best fit is obtained with $R = (1.6 \pm 0.25)$ fm, a little bigger than expected, but much more reasonable than the very large radii which were required in previous models. The maximum temperature $T_0 = (110 \pm 20)$ MeV corresponding to the fitted value of R is lower than the figure usually quoted in fits to high-energy transverse-momentum distributions, but still matches reasonably well with these distributions when the full chain of secondary decays is properly included in the analysis. Some general features of resonance decay which follow from the model are discussed: in particular, the linear dependence of the multiplicity of decay products on the mass of the resonance. (auth)

3793 QUARK-ORBITAL REGGE TRAJECTORIES. Nakkagawa, Hisao; Yamawaki, Koichi; Machida, Shigeru (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 939-63(Sep 1972).

It is shown that the pattern of Regge trajectories of hadrons becomes very much simpler and more regular than the usual Chew–Frautschi plot when one uses the orbital angular momentum of the quarks in a hadron instead of the spin of the meson and the spin minus ½ of the baryon, as the Reggeized angular momentum. Available data on particles and resonances are classified by means of the quark-orbital Regge trajectories, and as a result of it, the following pattern appears: there are linear rising quark-orbital trajectories with the universal slope for each irreducible representation of SU(6); actual hadron spectra are reproduced by adding the spin- and unitary spin-exchange interactions and the mass shift of the λ-quark. The Gell-Mann-Okubo mass formula holds rather good including resonances with high mass. Effects of the spin-orbit interaction are clearly recognized and its magnitude is nearly of the same order as those of the spin- and unitary spin-exchange interactions for mesons, whereas they are not so obvious for baryons. It follows from this splitting pattern of the quark-orbital Regge trajectories that the exchange degeneracies hold better for mesons than for baryons and that many "parity doublets" exist apparently and several parity partners should not appear, in conformity with experimental data. Classification of resonances using the orbital angular momentum between incoming two hadrons does not show much regularity. It is suggested from these results that strong interactions are essentially characterized by the degree of freedom of the spatial motion at the urbaryon level. (auth)

3794 PHENOMENOLOGY BASED UPON THE GENERALIZED VENEZIANO MODEL. Johnson, D. E. Ames, Iowa; Iowa State Univ. (1972). 58p. (IS-T-519). University Microfilms Order No. 72-26,923.

Thesis.

This study is made of the reactions $\bar{p}p \to \bar{p}p\pi^0$, $\bar{p}n\pi^+$, and $\bar{p}n\pi^-$ at 2.9 GeV/c using a model which combines Pomeron diffraction-dissociation diagrams with generalized Veneziano model diagrams. Three model parametrizations, which differ in their relative amounts of Pomeron and dual amplitudes allowed, are examined

for the $\bar{p}p\pi^0$ final state, and all are found to be in good agreement with the data. It is impossible to obtain a reasonable fit for the $\bar{p}n\pi^+$ and $p\bar{n}\pi^-$ final states with this model. (Diss. Abstr. Int., B)

3795 ANNIHILATION AT REST OF NUCLEON–ANTINUCLEON INTO THREE PIONS IN A DUAL QUARK MODEL. Franzen, G.; Roemer, H. (Univ., Bonn). Lett. Nuovo Cim.; 5: No. 10, 689-97(4 Nov 1972).

The meson four-point function of a dual quark model is compared to the experimental data on mass spectra and angular distributions for $\bar{p} + n \rightarrow \pi^+ + 2\pi^-$ and $\bar{p} + p \rightarrow \pi^+ + \pi^0 + \pi^-$ annihilation at rest. It is considered whether an amplitude with neutralizers can describe the data as well as the Veneziano models and to what extent the U(6W) vertex symmetry is broken. (J.F.P.)

3796 VECTOR MESONS AND THE π^0 LIFETIME. Bajaj, K. K.; Cordes, J. G. (Dalousie Univ., Halifax, Nova Scotia). Lett. Nuovo Cim.; 5: No. 10, 731-4(4 Nov 1972).

A new calculation of the constant S associated with the PCAC anomaly in $\pi^0 \rightarrow 2\gamma$ decay using the smoothness expansion technique combined with the Bjorken limit, and incorporating a multiplet of primed vector mesons in addition the usual φ, ω, and ϕ is reported. Only an outline of the derivation of the sum rules is given. A relatively low value of $g_{\omega\rho\pi}$ for the width of $\omega \rightarrow 3\pi$ decay is found. (J.F.P.)

3797 NONLINEAR PSEUDOSCALAR-MESON COUPLINGS FROM DIVERGENCE CONDITIONS. Weihofen, W. H. Detroit; Wayne State Univ. (1969). 106p. University Microfilms Order No. 72-16,240.

Thesis.

The goal is to unify the two principal dynamical ideas in strong and weak interactions into one simple yet powerful statement, considering the potential similarities between the two classes of interactions rather than their differences. The unifying postulate is that the source term in the pseudoscalar meson field equation be expressible as an exact divergence; this places a restriction on the axial vector current in the pseudoscalar meson interactions analogous to the conditions on the gravitational and electromagnetic currents, and guarantees that PCAC is satisfied. The basic problem remaining is to show that chiral dynamics, too, follows from the divergence condition; it is to this difficult problem of obtaining the nonlinear chiral dynamical pseudoscalar meson couplings without reference to chiral invariance that is addressed. It is found that, indeed, all chiral dynamical models for pion-nucleon interactions can be obtained directly from the divergence condition, whether the coupling is of the nonderivative or derivative type. Furthermore, the procedure is immediately extendible to the case of SU(3) symmetry with the same conclusion. In addition the application of the generalized equivalence theorem, used to establish the generality of the results, is demonstrated by making a complete calculation of a fourth order process (nucleon–nucleon scattering), including all renormalizations, using two different interactions related by an equivalence transformation. The investigation reveals that the dynamical content of the pion-nucleon interaction is embodied entirely in the divergence condition; and that chiral symmetry, broken intrinsically by the nonzero pion mass, is at best a phenomenological approximation; a viewpoint which seems to mark a terminus in the direction of recent research. The implications of these results are as broad as they are exciting. For, not only do they establish a method to obtain the form of interactions involving particles having internal symmetries, but they provide a clue to the unified treatment for the field theories of all the basic types of interactions. (Diss. Abstr. Int., B)

Strong (Baryon No. = 1)

Refer also to abstracts 3533, 3879, 3880, and 3933.

3798 (DESY–72/45) HIGH-ENERGY REACTIONS SEEN FROM THE S CHANNEL: A COMPLEX POLE IN THE IMPACT PARAMETER PLANE. Schrempp, B.; Schrempp, F. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Aug 1972. 41p. Dep. NTIS (U. S. Sales Only).

An s-channel model for inelastic reactions at high energies is presented. The scattering amplitude is split up into the contribution from the right hand cut ($T^{r.h.c.}$) and that from the left hand cut ($T^{l.h.c.}$) in a fixed-t dispersion relation. $T^{r.h.c.}$ is assumed to be dominated by the peripheral s-channel resonances associated with a complex pole $b_0(s)$ in the impact-parameter plane. It yields the rotating-phase part of the amplitude. $T^{l.h.c.}$ is assumed to be the analytic continuation of the analogous term in the u channel. It provides a real, nonperipheral background in the s channel. The predictions of this model for the t dependence of high energy amplitudes are confronted with experiment. A very good agreement is found in all cases. Moreover, an analytic expression for the complex pole trajectory $b_0(s)$ is presented which agrees with the experimentally determined one and with analyticity requirements. This crucially interlocks the two terms $T^{r.h.c.}$ (being a function of $b_0(s)$) and $T^{l.h.c.}$ (being a function of $b_0(u)$). (auth)

3799 (FRNC-R-14) $\bar{K}N$ LOW ENERGY REGION AND THE Y*(1405) COUPLING CONSTANTS. Leruste, P. (College de France, Paris. Laboratoire de Physique Atomique et Moleculaire); Strachman, Z. (Paris Univ. (France)). 1971. 66p. Dep. NTIS (U. S. Sales Only).

All available experimental data for $\bar{K}N \rightarrow \Lambda\pi\Sigma\pi$, $\bar{K}N$ and K^0_2p interactions in the momentum range $0 < k_{lab} < 280$ MeV momentum range are examined. Problems relating to unitarity and coupling constants are considered. A test for the compatibility with the data, based on the algebraic properties of the amplitudes is presented for 4 different models. The simplest degree law is used for the b-functions, such degree laws being related to the compositeness or elementarity type of particles, at least in the framework of the rational models. An attempt is made to introduce directly into the fits the constraints of exact SU_3 symmetry. A test of the hypothesis of extended unitarity is presented. A method based on the properties of algebraic functions was used to determine the coupling constants of Y*(1405) to the $\Sigma\pi$ and $\bar{K}N$ channels, and the singularity position. A correction is made to SU_3, which takes into account the $m_{Y^*}-m_N$ and $m_{Y^*}-m_\Sigma$ mass differences. The corrected value obtained for the ratio of the coupling constants is $R = 2$. An interpretation is proposed for Y*(1405), in the framework of the potential theory with a S-wave $\bar{K}N$ virtual bound state. (France)

3800 (PAM–71–5) INVERSE ELECTROPRODUCTION AT THE N*(1236) RESONANCE. Karatchentzeff, M.; Cochard, G.; Kessler, P.; Roehner, B. (College de France, Paris. Laboratoire de Physique Atomique et Moleculaire). Jun 1971. 25p. (CONF-710816–31). Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, NY, (23 Aug 1971).

The process $\pi^- + p \rightarrow l^- + l^+ + n$ (''inverse electroproduction'') was studied at the energy of the N*(1236), using a model of the type ''isobar plus Born terms.'' It is shown that: electromagnetic form factors don't play an important role in the physical region concerned; in sharp contradistinction to electroproduction, the Born terms should largely predominate in this process over the isobar terms; the total cross sections should be high enough ($\simeq 5.10^{-31}$ cm^2 for electron pairs, and $\simeq 10^{-31}$ cm^2 for muon pairs) to make such an experiment possible with existing proton accelerators. Predicted distributions with respect to various parameters in the laboratory are shown. Some details are given about the methods of calculation. (auth)

3801 PION FRAGMENTATION IN PERIPHERAL DYNAMICS. Butera, P. (Univ., Parma, Italy); Enriotti, M.; Duimio, F.; Marchesini, G. Phys. Lett.; 41B: No. 4, 521-4(16 Oct 1972).

Peripheral dynamics is studied for the limiting fragmentation of a pion into pions. The calculated distributions are discussed and compared with experimental data. (auth)

3802 DUALITY AND HIGH-ENERGY LIMIT OF FORWARD PION–NUCLEON SCATTERING AMPLITUDE. Aramaki, S. (Nagoya Univ., Japan). Lett. Nuovo Cim.; 5: No. 5, 409-12(30 Sep 1972).

The residues of both the Pomeranchuk (P) and P′ trajectories of the pion-nucleon scattering are calculated in terms of the low-energy resonance parameters by combining the duality and Sugawara approaches. In this approach, the intercepts of the P and P′ trajectories $\alpha_P(0)$ and $\alpha_{P'}(0)$ are given respectively the values 1 and ½ as input. The result of the calculations given a reasonable agreement with high-energy experimental data of the appropriate threshold factor is introduced into the nonresonant background contribution in the Freund–Harari ansatz. (L.B.S.)

3803 ISOSPIN BOUNDS AND ZEROS PION–NUCLEON SCATTERING AMPLITUDES. Hoehler, G.; Kaiser, F.; Kohl, H.; Schmidt, W. (Univ., Karlsruhe, Ger.). Lett. Nuovo Cim.; 5: No. 5, 413-19(30 Sep 1972).

Phase contours are used to analyze the isospin bounds and to locate the zeros of the πN scattering amplitude. (L.B.S.)

3804 RESONANCE AND BACKGROUND CONTRIBUTIONS TO MESON–NUCLEON TOTAL CROSS SECTIONS. Chylek, P.; Lichtenberg, D. B. (Indiana Univ., Bloomington). Lett. Nuovo Cim.; 5: No. 5, 435-42(30 Sep 1972).

The consequences of two-component duality conjectured by Freund and Harari for pion-nucleon and kaon-nucleon total cross sections in the intermediate energy region between 1 and 4 Gev/c are considered. It is shown that if the Freund–Harari conjecture

is correct, then there should exist a substantial number of as yet undiscovered πN and $\bar{K}N$ resonances. (L.B.S.)

3805 CONSISTENCY OF πN FORWARD-SCATTERING DATA WITH ANALYTICITY AND CROSSING. Caprini, I. (Inst. for Atomic Physics, Bucharest). Lett. Nuovo Cim.; 5: No. 5, 443-7 (30 Sep 1972).

A test for consistency of scattering data with the hypothesis of analyticity and crossing is constructed for the pion-nucleon charge-exchange forward amplitude. It is found that the data with the error show noticeable deviations from analyticity and crossing. (L.B.S.)

3806 NEW DETERMINATION OF THE PION–NUCLEON SIGMA TERM. Hakim, S. J. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 5: No. 5, 377-81 (30 Sep 1972).

A new determination is made of the pion-nucleon sigma term based on equal-time commutator parametrization of the rescattering effects. The average of the values obtained is $\sigma = (51 \pm 9)$ MeV. (L.B.S.)

3807 ABFST MODEL WITH VENEZIANO AMPLITUDES FOR $\pi\pi$ AND πp SCATTERING APPLIED TO THE REACTION $\pi^+p \to 3\pi^+2\pi^-p$ AT 8 GeV/c. Pokorski, S. (Univ., Warsaw); Szeptycka, M.; Zieminski, A. Acta Phys. Pol., B3: No. 5, 551-64(1972).

The ABFST model with dual amplitudes taken to describe the off-mass shell $\pi\pi$ and πp scattering is applied to the reaction $\pi^+p \to 3\pi^+2\pi^-p$ at 8 GeV/c. Previously the same process was studied in the framework of the ABFST model with $\pi\pi$ and πp phase shifts and the Dürr–Pilkuhn off-shell extrapolation. However this extrapolation is known to disagree with the existing data on the off-mass shell $\pi\pi$ scattering. By comparing the results of both calculations the dependence of the ABFST model description on a particular method of the off-mass shell extrapolation is studied. Also the predictions of the model are compared with experimental data using the Van Hove longitudinal phase-space method. (auth)

3808 DETERMINATION OF THE PION–NUCLEON COUPLING CONSTANT AND s-WAVE SCATTERING LENGTHS. Samaranayake, V. K. (Univ. of Ceylon, Colombo); Woolcock, W. S. Nucl. Phys., B48: No. 1, 205-24(1972).

Presently available values of D_+, the real parts of the $\pi^\pm p$ elastic scattering amplitudes in the forward direction in the laboratory frame, obtained by extrapolation of experimental data to the forward direction, have been fitted up to a pion lab. kinetic energy of 2 GeV using forward dispersion relations. A substantial number of data points have to be discarded to obtain a reasonable goodness of fit. Above 300 MeV the values of D_+ obtained from the CERN phase shift analysis are strongly favored compared with those from the Saclay analysis. The final results for the pion-nucleon coupling constant and s-wave scattering lengths are: $10^3 f^2 = 76.3 \pm 2.0$, $10^3 D_+(\mu) = -102.4 \pm 5.2$, $10^3 D_-(\mu) = 104.8 \pm 5.4$, $10^3 (a_1 - a_3) = 270.6 \pm 11.3$, and $10^3 (a_1 + 2a_3) = 3.1 \pm 8.0$. The errors quoted take account of experimental uncertainties and also attempt to include systematic errors arising from the unphysical continuum and from the very high energy region. Coulomb barrier corrections have not been included. The results are compared with other determinations of the same quantities and their implications discussed. (auth)

3809 PHYSICAL MESON–BARYON SCATTERING IN THE CANONICAL ALGEBRA. Hakim, S. J. (Univ. of Michigan, Ann Arbor). Nucl. Phys., B48: No. 1, 265-8(1972).

a recalculation of the meson-baryon scattering lengths yielded a good agreement with experimental data and a qualitative agreement with a previous calculation of Von Hippel and Kim. The connected matrix element of the singlet member of the SU(3) ⊗ SU(3) scalar nonet (3,3*) + (3*,3) between baryon states μ_0 was found to be 290 ± 32 MeV and the pion-nucleon σ-term 30 ± 2 MeV. (auth)

3810 ABSENCE OF MACDOWELL DOUBLETS, DUALITY SOLUTIONS FOR BARYONS, AND BACKWARD πN SCATTERING AT 6 GeV/c. Minkowski, P. (CERN, Geneva). Nucl. Phys., B48: No. 1, 247-64(1972).

An attempt is made to compare restrictions on baryon-exchange Regge residues demanding absence of MacDowell doublets and incorporating an approximate duality solution for the decuplet exchange with experimental data on πN backward cross sections and polarizations at $p_{lab} = 6$ GeV/c. Although the gross features of cross sections and polarizations can be obtained from N_α, Δ_δ, Δ_β exchanges, substantial contributions of another nature are needed to describe all details of the data. (auth)

3811 THERMODYNAMICAL MODEL CALCULATION OF INCLUSIVE LONGITUDINAL MOMENTUM SPECTRA OF PIONS IN Kp REACTIONS. Buschbeck, B.; Hoedl, J. (Institut fuer Hochenergiephysik, Vienna). Nucl. Phys., B48: No. 1, 288-94 (1972).

The c.m. longitudinal momentum spectra for $Kp \to \pi$ + anything were calculated from the thermodynamical model using the velocity weight function of Hagedorn and Ranft found in pp interactions. Comparison with experimental data show that the c.m. forward backward asymmetry of the π-spectra is reproduced by the calculations. (auth)

3812 DETERMINATION OF f^0NN AND gNN COUPLING CONSTANTS. Aaron, R.; Goldberg, H. (Northeastern Univ., Boston). Phys. Rev., D; 6: No. 9, 2704-9(1 Nov 1972).

Using backward πN dispersion relations (BDR) and sum rules derived from BDR the spin-flip f^0NN and a combination of the flip and nonflip gNN coupling constants are obtained, and certain backward πN data are fitted. The results have implications in the one-boson-exchange theory of the nucleon–nucleon force and in theories of elementary particles which assume universal coupling to the stress tensor. (auth)

3813 REGGE EFFECTS IN $V^0\Delta^{++}$ PRODUCTION. Peaslee, D. C. (Australian National Univ., Canberra). Phys. Rev., D; 6: No. 9, 2693-6(1 Nov 1972).

It is argued that a recent interpretation of unnatural-parity exchange in $\rho^0\Delta^{++}$ and $\omega^0\Delta^{++}$ production becomes more satisfactory if a second exchange-degenerate trajectory is introduced in addition to the π-B: namely, A_1-R. Two advantages are the allowance of a realistic slope for the π-B trajectory and interpretation of the narrow dip in ω^0 production near $t = -0.25$ (GeV/c)^2 as a ghost effect. The broad dip near $t = -0.75$ (GeV/c)^2 for ρ^0 production becomes more flexibly interpreted, and it could vanish under suitable circumstances. (auth)

3814 CORRELATIONS IN HIGH-ENERGY PRODUCTION PROCESSES. Berger, E. L. (Argonne National Lab., Ill.); Jacob, M.; Slansky, R. Phys. Rev., D; 6: No. 9, 2580-96(1 Nov 1972).

Rapidity distributions for two-particle inclusive reactions are calculated from the nova model which has been successful at reproducing the single-particle distributions. Particular attention is given to the $2\pi^-$ correlations in π^+p and pp collisions for which data are available. Good agreement with data provides further evidence for a strong clustering of secondaries in particle production at present machine energies, a feature inferred previously from the analysis of single-particle distributions. The importance of measuring the energy dependence of $\langle n(n-1)\rangle$, the quantity which normalizes the two-particle distribution, is stressed. A number of other features of correlation experiments are discussed. General properties of particle production are emphasized in reviewing the nova model. (auth)

3815 AMPLITUDE ANALYSIS OF CHARGE-EXCHANGE AND STRANGENESS-EXCHANGE PROCESSES IN PSEUDOSCALAR-MESON–BARYON SCATTERING USING THE DUAL ABSORPTIVE MODEL. Loos, J. S.; Matthews, J. A. J. (Stanford Univ., Calif.). Phys. Rev., D; 6: No. 9, 2463-83(1 Nov 1972).

An amplitude analysis of charge-exchange and strangeness-exchange reactions in pseudoscalar-meson–baryon scattering is presented for the momentum interval ~4 to ~16 GeV/c. The imaginary parts of the s-channel helicity-nonflip and helicity-flip amplitudes are assumed to have "J_0" and "J_1" structures, respectively, as specified by the dual absorptive model of Harari. This model has been successful previously in explaining the main features of elastic scattering data. The present analysis applies this model to inelastic scattering reactions and determines empirically the real part of the s-channel nonflip amplitude from the data. The resulting amplitudes reproduce well the existing differential cross section and polarization data for charge-exchange and strangeness-exchange reactions. The ρ and A_2 amplitudes in KN charge exchange are found to be in approximate agreement with strong exchange degeneracy. In contrast, the K* and K** amplitudes in Σ and Λ reactions are not strongly exchange-degenerate, even though equal forward differential cross sections are observed for the line-reversed pairs of reactions $\pi N \to KY$ and $\bar{K}N \to \pi Y$. (auth)

3816 RECIPROCAL BOOTSTRAP OF N AND N* WITH A NONPOLYNOMIAL LAGRANGIAN. Patil, S. H.; Sharma, S. K. (Indian Inst. of Tech., Bombay). Phys. Rev., D; 6: No. 9, 2574-9 (1 Nov 1972).

A calculation of the reciprocal bootstrap of N and N* is carried out, using a nonpolynomial Lagrangian given by Weinberg. The multipion intermediate states are included in the static Bethe–Salpeter equation and the N/D equations, and obtain results free from cutoff parameters. It is found that the asymptotic behavior of the πN scattering amplitude depends only on the minor cou-

pling constant and decreases exponentially. The dynamical parameters calculated are $\gamma_{NN\pi} = 3f^2 \simeq 0.23$, $\gamma_{N^*N\pi} \approx 0.12$, and $m_{N^*} - m_N \approx 1.5m_\pi$, as compared to the corresponding experimental numbers of 0.24, 0.12, and $2.1m_\pi$. (auth)

3817 BACKWARD SCATTERING IN THE REACTION $\pi^-p \rightarrow \rho^0\pi^-p$ AT 5 GeV/c. Harms, B. C.; Jones, S. T. (Univ. of Alabama, University). Phys. Rev., D; 6: No. 9, 2437-44(1 Nov 1972).

Two models for backward pion–proton scattering are used in an investigation of nonperipheral events in the process $\pi^-p \rightarrow \rho^0\pi^-p$. A multi-Regge model, incorporating baryon and pion exchange, is found to reproduce angular distributions well, but does a poor job describing invariant masses. A second model, incorporating on-shell pion–nucleon phase shifts, fits all aspects of the data. Pion exchange in both models is well supported. Speculations regarding inclusive reactions stress the inadequacy of single-particle spectra in distinguishing between different models. (auth)

3818 PARTON MODEL, ELECTROMAGNETIC FORM FACTORS OF HADRONS AND HIGH ENERGY ELASTIC $\pi^\pm p$ SCATTERING. Raychaudhuri, P. (Univ., Oulu, Finland). J. Phys., A (London); 5: No. 10, L97-101(Oct 1972).

Following the idea of Wu and Yang (Phys. Rev. 137, B708, 1965) that the electromagnetic and nuclear distributions behave similarly at large momentum transfer, a study was made of the differential cross section for $\pi^\pm p$ elastic scattering at high energy within the framework of the parton model. By using the idea of Drell and Yan (Phys. Rev. Lett. 24, 181, 1970) the electromagnetic form factors of the pion and proton were calculated and they are shown to decrease as $t^{-\frac{1}{2}}$ and t^{-2} respectively at large t. (auth)

3819 ERICSON FLUCTUATIONS AND THE BOHR MODEL IN HADRON PHYSICS. Frautschi, S. (CERN, Geneva). Nuovo Cim.; 12A: No. 1, 133-61(1 Nov 1972).

Analogies between the statistical bootstrap model for hadrons and the familiar statistical model for nuclei are pointed out, and used as a guide for suggesting new statistical treatments of hadron reactions: the Fermi statistical model is modernized by including the full Hagedorn spectrum of resonances, and brought into correspondence with the Bohr model by assuming that the reaction proceeds via an incoherent sum over direct-channel resonances; a definite prescription is given, predicting which hadron reactions should exhibit Ericson fluctuations; it is shown that the peaks and dips in πN elastic scattering between p = 1.5 and 5 GeV/c can be interpreted as Ericson fluctuations, although further experiments are needed to establish this interpretation definitively; the rapidly falling cross sections found in exotic exchange reactions such as backward $K^-p \rightarrow K^-p$ are interpreted as the incoherent part of the sum over a Hagedorn spectrum of direct-channel resonances; especially large Ericson fluctuations are predicted for such cases. (auth)

3820 TEST OF FACTORIZATION IN $p + \pi^- \rightarrow p + X$ AND $p + p \rightarrow p + X$ NEAR THE KINEMATICAL LIMIT. Wong, T. F. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Rev., D; 6: No. 9, 2410-12(1 Nov 1972).

New data on $p + \pi^- \rightarrow p + X$ at 25 GeV/c and 40 GeV/c and $p + p \rightarrow p + X$ at 19 GeV/c and 24 GeV/c are examined. The normalized cross sections of these two reactions agree with each other within 10% near the kinematical limit. (auth)

3821 DUAL AMPLITUDE FOR REACTIONS $\pi N \rightarrow \omega N(\Delta)$ AND $\pi\Delta \rightarrow \omega\Delta$ AND RELATIONS BETWEEN COUPLING CONSTANTS. Miyata, Yasunori (Tokyo Inst. of Tech.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 892-9(Sep 1972).

Dual amplitudes involving baryons are studied for the reactions $\pi N \rightarrow \omega N(\Delta)$ and $\pi\Delta \rightarrow \omega\Delta$, and relations among residues of special poles are obtained at a point in Mandelstam plane. The vector (tensor) part of the ρ-exchange amplitude in the t-channel has a correspondence to the tensor (vector) part of the N_α-exchange amplitude in the s-(u-) channel in the reaction $\pi N \rightarrow \omega N$. Relations between the coupling constants $(G_{T\omega}/G_{V\omega}) = (m^2/m_\omega^2)(G_{Tp}/G_{Vp})^{-1}$, etc., are obtained. They agree well with the available experimental data. (auth)

3822 HELICITY CONSERVATION AND DIFFRACTIVE PROCESSES. Kuroda, Masaaki; Yamaguchi, Yoshio (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 888-91(Sep 1972).

Helicity properties of diffractive processes are examined, and a model for the diffractive production processes is proposed which gives a clue to the solution of the puzzle of t-channel versus s-channel helicity conservations. (auth)

3823 UNITARIZATION AND OBE CONTRIBUTION IN HIGH ENERGY HADRON SCATTERING. Inagaki, Toshio (Tokyo Metropolitan Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 868-76(Sep 1972).

The significance of the unitarized model with the form $S = e^{iH}$ (H is Hermitian) is studied in high energy hadron scattering. The H-matrix elements are replaced by OBE amplitudes. This model satisfies the two important properties in high energy phenomena, that is, unitarity and no direct-channel resonance contribution as observed through the flatness of the total cross sections. Numerical calculations are made for the differential cross sections for p-p, π^--p and K^--p elastic scattering, the results are good except for p-p scattering. (auth)

3824 RESONANCE FLIP OF NEUTRON POLARIZATION IN SPACE-PERIODIC MAGNETIC FIELDS. Drabkin, G. M.; Ruban, V. A.; Sbitnev, V. I. Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 5, 855-60(Nov 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 5, 1076-83(May 1972).

A matrix method is proposed for solving the problem of the resonance spin of slow polarized neutrons in pulsed space-periodic magnetic fields. Magnetic-resonance neutron filters are discussed. (auth)

3825 TWO-BODY BARYON MODEL. Ono, Seiji (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 964-73(Sep 1972).

Baryons and mesons are constructed on the assumption that their constituent particles are the $\frac{1}{2}^+$ triplet and the 1^+ sextet. The model is a modification of the quark–diquark model of Lichtenberg, and improves on the quark model in the following points: Constituent particles need not obey para-statistics but only the normal spin-statistics relation. In the quark model there is the dynamical difficulty that Q, QQ, QQQQ, ··· are so heavy that they cannot be observed while QQQ, $Q\bar{Q}$ are so light. The model does not have such difficulties. Even in the para-quark model one must consider why only SU(6) symmetric states are observed. In the model one need not consider the symmetry of the wave function. Following the model an attempt was made to classify and assign the baryon resonances. The strong decay rates of the baryon resonances are also calculated. (auth)

3826 ISOSPIN CONSERVATION AND THE CHOICE OF B_s AMPLITUDES FOR $KN \rightarrow K\pi N$ REACTIONS. Helfman, J.; Berlad, G.; Goldberg, J. (Technion-Israel Inst. of Tech., Haifa). Lett. Nuovo Cim.; 5: No. 10, 701-6(4 Nov 1972).

The most general spinless dual amplitude describing the set of reactions $KN \rightarrow K\pi N$ is derived by imposing isospin, charge conjugation, crossing symmetry, and the absence of exotic states. The resulting amplitude contains only one overall normalization coefficient and a single free parameter expressing the relative contribution of N_α and N_γ exchange. (J.F.P.)

3827 TWO PION PRODUCTION VIA DOUBLE POMERANCHUK EXCHANGE AND ITS RELATION TO PIONIZATION. Mehta, C. H. San Diego, Calif.; Univ. of California (1972). 99p. University Microfilms Order No. 72-25,733.

Thesis.

Mueller analysis relates the single-particle inclusive spectrum in the pionization region to the discontinuity of forward three-particle scattering amplitude dominated by double-Pomeranchuk exchange. From the analysis of inclusive cross section in the pionization region, double-Pomeranchuk coupling in the three-particle amplitude seems "large." On the other hand, experimentally, double-Pomeranchuk exchange was not found in a study of $\pi^-p \rightarrow \pi^-(\pi^+\pi^-)p$. This paradoxical behavior of double-Pomeranchuk exchange is explored using two simple models for the analytical continuation of a six-line amplitude from the production region to the pionization region. (Diss. Abstr. Int., B)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 3530 and 3657.

3828 (GWI-PH-2/72) ρ MESON PRODUCTION IN π^4He INTERACTIONS. Ekeloef, Tord (Uppsala Univ. (Sweden). Gustaf Werner Inst.). May 1972. 17p. Dep. NTIS (U. S. Sales Only).

Theoretical predictions about the coherent ρ meson production in π^4He interactions at multi-GeV energies are discussed. The Regge and Glauber theories are used for calculations of the production differential cross section at 6 GeV/c incident momentum. It is concluded that information on the ω trajectory, the ω exchange part of the amplitude for ρ hadroproduction on nucleons and the phase of the ρN scattering amplitude can be obtained from measurements of this reaction. (auth) (Sweden)

3829 (NP-19472) TRIPLE-REGGE PHENOMENOLOGY FROM FINITE MASS SUM RULES IN SINGLE PARTICLE INCLUSIVE REACTIONS. Internal Note No. 379. Bietti, A. (Rome Univ. (Italy). Istituto di Fisica. Istituto Nazionale di Fisica Nucleare, Rome (Italy)). 22 May 1972. 8p. Dep. NTIS (U. S. Sales Only).

Finite-mass sum rules are used for the reactions $p + p \to \{^{k^\pm}_{\pi^\pm}$ + anything, in order to obtain the high missing mass (m_x^2) behavior in terms of an integral over the low and intermediate m_x^2 amplitudes. From the CERN data at incident laboratory momenta of 24 and 19.2 GeV/c results are obtained that are in reasonable agreement, particularly for the $K^\pm$ reactions, with the predictions of the triple-Regge model. (auth)

3830 ELASTIC HADRON-CARBON SCATTERING. Gobbi, B.; Hakel, W.; Rosen, J. L.; Shapiro, S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 29: No. 18, 1278-81(30 Oct 1972).

The small-angle elastic scattering of π^+, π^-, K^+, K^-, p, and $\bar{p}$ incident on carbon was measured at an incident momentum of 2.01 GeV/c. Measurements of $K^\pm$ at 1.68 and 2.26 GeV/c were also recorded. The differential cross section $d\sigma/dq^2$ and the total nuclear cross section σ_T are given. Data fitting provides values for the complex forward scattering amplitude, f(0), and the slope parameter of the diffractive scattering distribution for each incident energy and particle. (auth)

3831 ABUNDANCE OF PHOTONS IN THE PIONIZATION REGION. Saito, K.; Sakai, S. (Tokyo Univ. of Education). Phys. Lett.; 41B: No. 4, 499-501(16 Oct 1972).

The ISR data on $p + p \to \gamma +$ "X" at $\theta = \frac{1}{2}\ \pi$ is studied. It is shown that the photons from π^0 decay take only about 20% ~80% of experimental inclusive cross section. The subtractions of the photons which are decay products of π^0, from the experimental data are made. The remaining photons have the similar distribution function as that of $\pi^\pm$, in the large $k^2_\perp$ region, if the pion mass is taken to be equal to zero, while in the small $k^2_\perp$ region, they have the sharper peak at $k^2_\perp \approx 0$ than $\pi^\pm$-distribution function. (auth)

3832 PARTICLE PRODUCTION RATIOS IN THE DIFFRACTIVE EXCITATION MODEL. Hwa, R. C.; Robertson, D. C. (Univ. of Oregon, Eugene). Phys. Lett.; 41B: No. 4, 502-6(16 Oct 1972).

Ratios of the invariant distributions of produced particles, $R(\pi^+/\pi^-)$, $R(\bar{p}/\pi^-)$, $R(K^-/\pi^-)$ and $R(K^+/p)$, were calculated in the diffractive excitation model. Two free parameters are used to adjust the relative normalization. The shapes of the ratios as functions of x are essentially independent of any arbitrary parameters. The results agree with the data very well. (auth)

3833 MASSIVE LEPTON PAIR PRODUCTION AND THE SIZE OF THE PHOTON. Etim, E. (CNEN, Frascati, Italy); Greco, M.; Srivastava, Y. N. Phys. Lett.; 41B: No. 4, 507-10 (16 Oct 1972).

An intuitive picture for understanding scaling in hadronic as well as nonhadronic processes is proposed which makes use of shrinkage of the size of the particle with its mass. An explicit model in agreement with experiment is also discussed. (auth)

3834 EXPERIMENTAL CONSEQUENCES OF MULTIPERIPHERAL BOOTSTRAP MODEL. Ball, J. S.; Zachariasen, F. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Lett.; 41B: No. 4, 525-8(16 Oct 1972).

Lower energy corrections to a recently proposed model of high energy elastic scattering are estimated and the predictions of the model compared with experiment. The agreement with the t-dependence of pp elastic differential cross sections at small t is excellent, but the agreement with the s-dependence is less compelling. (auth)

3835 SOLUTION OF THE SKORNYAKOV-TER-MARTIROSYAN EQUATIONS FOR THREE NUCLEONS WITH CUT OFF AT LARGE MOMENTA. Kharchenko, V. F. (Inst. of Theoretical Physics, Kiev). Yadern. Fiz.; 16: No. 2, 310-15(Aug 1972). (In Russian).

The consistency of three nucleon low-energy parameters in the doublet spin state is studied on the basis of Skornyakov-Ter-Martirosyan equations with cutoff at large momenta. The deuteron binding energy and singlet length of np-scattering are used as two nucleon parameters. The cutting parameter introduced is fixed over the value of the binding energy of triton. The value of the doublet length of nd-scattering, calculated in this way, is in agreement with the experimental values by Hurst-Alcock and Dilg-Koester-Nistler. (auth)

3836 OFF-SHELL BEHAVIOR IN PERIPHERAL DYNAMICS AND INCLUSIVE SUM RULES. Bishari, Mordechai (Univ. of California, Berkeley). Nucl. Phys., B48: No. 1, 325-32(1972).

The usefulness of inclusive unitary for constraining dynamical models is illustrated by a specific example. Using inclusive sum rules together with measurable inclusive processes, an estimate is given for a parameter which determines the scale for the off-shell extrapolation in the ABFST model. (auth)

3837 APPLICABILITY OF THE METHOD OF MAXIMUM MOMENTUM IN THE ANALYSIS OF TWO-PARTICLE REACTIONS. Takibaev, Zh. S.; Boos, E. G.; Lukin, E. S. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 6, 53-7(1971). (In Russian).

Quantitative evaluations of the limitation of the region of applicability of the maximum momentum method were made. Calculations were conducted on various two-particle reactions from the pp-interaction. The method described may be successfully used for analyzing interactions at energies greater than 5 GeV. (tr-auth)

3838 TWO PARTICLE AZIMUTHAL CORRELATION IN MULTIPERIPHERAL DYNAMICS. Duimio, F.; Marchesini, G. (Univ., Parma, Italy). Nucl. Phys., B48: No. 1, 318-24(1972).

The asymptotic two-particle distribution function is studied in the framework of the ABFST model. The azimuthal correlation is discussed for pairs of pions produced in the pionization region with c.m. longitudinal momenta lying in opposite hemispheres. Such a correlation effect is shown to persist for values of the mass $\sqrt{s'}$ of the two-pion system beyond the resonance region. An estimate of its strength, essentially free from arbitrary parameters, is given for $s' \gtrsim 2\ GeV^2$. (auth)

3839 DIFFRACTIVE DISSOCIATION AND CORRELATIONS IN INCLUSIVE SPECTRA. Bialas, A. (Jagellonian Univ., Krakow); Fialkowski, K.; Zalewski, K. Nucl. Phys., B48: No. 1, 237-46(1972).

It is pointed out that the superposition of two different mechanisms of particle production may lead to positive long-range correlations between particles in inclusive spectra. The interplay of diffractive dissociation and non-diffractive particle production is discussed in some detail and it is suggested that this effect may account for a large fraction of the correlations observed in the process $p + p \to \pi^- + \pi^-$ + anything at high energies. (auth)

3840 SOLVABLE UNITARY MODEL WITH CLUSTER DECOMPOSITION FOR MULTIPRODUCTION OF DISTINGUISHABLE PARTICLES. Redei, L. B. (CERN, Geneva). Nuovo Cim.; 12A: No. 1, 249-62(1 Nov 1972).

A solvable model is presented for multiproduction of distinguishable particles. The scattering amplitude satisfies many-particle unitarity, cluster decomposition with respect to the produced particles and Lorentz invariance. The analytic properties and the high-energy limit of the model are discussed. (auth)

3841 IMPACT PICTURE AND SCATTERING OF DEUTERONS. I. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, T. T. Phys. Rev., D; 6: No. 9, 2637-46(1 Nov 1972).

The theory of the impact picture is applied to the process of scattering of deuterons. It is shown that the impact-factor representation plays the same role in a complete relativistic scattering process as the Glauber form does in the scattering of a particle on a static deuteron. Therefore, as the impact-factor representation is used for the deuteron scattering amplitude, the recoil effects of the deuteron are included automatically which must be taken into account when the recoil momentum of the deuteron is not much smaller than the deuteron mass. The main difference between the impact-factor representation and the Glauber form is that in the impact-factor representation, the internal wave function of the outgoing particle is Lorentz-contracted. This also accounts for the difference found earlier between results in quantum electrodynamics and the corresponding ones in the droplet model. To obtain the Lorentz-contracted wave function explicitly, the Lorentz transformation equations relating the laboratory system and the recoil system, defined to be the system in which the outgoing deuteron is at rest, is given. (auth)

3842 HYPERON-NUCLEON SCATTERING. I. INVARIANT AND HELICITY AMPLITUDES. Liu, Yu-chien (Univ. of Nijmegen, Netherlands). Phys. Rev., D; 6: No. 9, 2513-21(1 Nov 1972).

The invariant and helicity amplitudes for A + B → C + D, where A, B, C, and D are $J^P = \frac{1}{2}^+$ particles are investigated. New variables are introduced to simplify the otherwise complicated expressions for the regularized, parity-conserving helicity amplitudes in all three channels. Simple algebraic methods are used to derive the equivalence theorems and the Fierz transformations for four spinors. The reduction of this general formalism to describe hyperon-nucleon scattering (e.g., $\Sigma N \to \Lambda N$, $\Sigma N \to \Sigma N$) is immediate. (auth)

3843 REGGEIZED DECK MODEL FOR $pp \to p\pi^+\Delta^0$ AND $pp \to p\pi^-\Delta^{++}$. Griffiths, David; Saperstein, A. M.; Schnitzler,

D. T. (Wayne State Univ., Detroit). Phys. Rev., D; 6: No. 9, 2546-53(1 Nov 1972).

The Reggeized Deck model is shown to describe, simultaneously, the two processes $pp \rightarrow p\pi^+\Delta^0$ and $pp \rightarrow p\pi^-\Delta^{++}$, without relying on adjustable parameters. In the framework of this model, parameters already determined from two-body scattering data must be used to describe three-body processes. Special attention is given to the lab-momentum dependence of the total cross sections; the model gives the magnitudes of the two cross sections correctly and explains why they are different. Two production mechanisms are found to be important in $pp \rightarrow p\pi\Delta$. One involves π exchange and $\pi p \rightarrow \pi p$ elastic scattering; the other involves π exchange and $\pi p \rightarrow \pi\Delta$ scattering. A straightforward parametrization of experimental data is employed to describe $\pi p \rightarrow \pi p$ scattering. Direct parametrization of $\pi p \rightarrow \pi\Delta$ scattering is not possible, since the cross section for this process has not been measured well in the energy regions of interest. However, $\pi p \rightarrow \pi\Delta$ scattering is dominated by nucleon resonances; so a sum over these resonances, whose parameters are known, is used to represent this process. (auth)

3844 DECK MODEL FOR TRIPLE-REGGE COUPLINGS. Sorensen, C. (Univ. of California, Berkeley). Phys. Rev., D; 6: No. 9, 2554-9(1 Nov 1972).

Inclusive cross sections in the triple-Regge region are calculated using a version of the Amati–Bertocchi–Fubini–Stanghellini–Tonin (ABFST) multiperipheral model that amounts to an extension of the Deck model. Even though almost no parameters are available for adjustment, presently available moderate-energy data are described in a qualitatively satisfactory manner. Predictions are made for future experiments at higher energies, and the various triple-Regge couplings are extracted from the model. It is found that vertices corresponding to high-lying trajectories are suppressed. In particular the dimensionless parameter η_{PPP} that characterizes the triple-Pomeranchon vertex turns out to be $\lesssim 10^{-3}$. (auth)

3845 SINGLE-PARTICLE DISTRIBUTIONS IN A HADRONIC BREMSSTRAHLUNG MODEL. Fried, H. M. (Brown Univ., Providence); Gaisser, T. K. Phys. Rev., D; 6: No. 9, 2560-73 (1 Nov 1972).

It is shown that the inclusive cross section for production of a single soft, neutral vector meson in pp scattering vanishes like $1/s$ at $p_{||}/p_{||max} = 0$ in the center-of-mass system for mesons radiated from the external nucleon legs. Comparison of the resulting single-pion distribution with the CERN Intersecting Storage Rings data makes it unlikely that present data in the pionization region can be understood in a conventional bremsstrahlung picture. (auth)

3846 QUADRUPOLE-MOMENT EFFECT IN QUASI-ELASTIC DEUTERON–DEUTERON SCATTERING. Bertocchi, L. (Univ., Trieste, Italy); Tekou, A. Nuovo Cim.; 12A: No. 1, 1-11(1 Nov 1972).

The effect of the deuteron quadrupole moment is computed for quasi-elastic deuteron-deuteron scattering in the framework of Glauber theory. It is shown that, as in elastic πd and pd scattering, the effect of the D-wave is such that the dip, caused by the interference of single- and double-scattering amplitudes, is completely filled in the unpolarized cross section. However, dips are present in the polarized cross sections; their presence could be detected by performing an experiment with polarized deuteron beams (or targets). (auth)

3847 PARITY VIOLATION IN PROTON SCATTERING. Simonius, M. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett.; 41B: No. 4, 415-18(16 Oct 1972).

The possibility of high-accuracy measurements of the parity-violating analyzing power for longitudinally polarized protons (in particular, for p–p scattering) is pointed out. Underlying theory and significance of such measurements for weak- and strong-interaction physics are discussed. (auth)

3848 SCALING OF INCLUSIVE γ SPECTRA $p + p \rightarrow \gamma + X$ AT ISR ENERGIES AND THE THERMODYNAMIC MODEL. Htun Than; Kripgfanz, J.; Mueller, V.; Ranft, G.; Ranft, J.; Blutner, R. (Karl Marx Univ., Leipzig). Lett. Nuovo Cim.; 5: No. 7, 537-42(14 Oct 1972).

It is pointed out that inclusive spectra of charged pions are reliably calculated using the thermodynamic model. The same should be true for inclusive neutral pion spectra. The inclusive spectra for $p + p \rightarrow \gamma +$ anything interactions are obtained from the π^0 spectra only. The scaling behavior of the spectra is shown. (J.F.P.)

3849 MUON PAIR CREATION VIA TWO-PHOTON EXCHANGE IN CHARGED-PARTICLE COLLISIONS. II. HADRON COLLISIONS. Fujikawa, K. (Univ. of Chicago). Contract AT(11-1)-264. Nuovo Cim.; 12A: No. 1, 117-32(1 Nov 1972).

Muon pair creation via two-photon exchange in charged-hadron collisions is discussed on the basis of a numerical calculation as well as an analytical formula. The form factor and also the large mass of hadrons make this cross section very small for a large invariant mass of the muon pair at low energies. However, at extremely high energies and for not so massive muon pairs the present process becomes comparable with other semi-leptonic processes. This process may be measurable at NAL energies. Also the q^2 dependence of the missing-mass spectrum in the ordinary deep inelastic process is briefly discussed on the basis of a muon-parton analogy. (auth)

3850 TRITON BINDING ENERGY BY THE FADDEEV APPROACH WITH TWO-BODY LOCAL INTERACTIONS. Purkayastha, G. (Indian Association for the Cultivation of Science, Calcutta); Sil, N. C.; Banerjee, S. N. J. Phys., A (London); 5: No. 10, 1495-1501(Oct 1972).

An analytical and separable representation was suggested for the two-particle S wave t matrix, for the central Yukawa interactions, which is separable and symmetric in momentum variables p and p'. The sturmian eigenfunctions for the S-wave Hulthen potential, which form a complete set, were used as the expansion bases. For the neutron-proton system, the triplet and the singlet states were considered, including the soft-core repulsion in the singlet interaction. The resulting t matrix was used as an input in the Faddeev equation for the neutron-deuteron collision problem, and the triton binding energy was computed and compared with the theoretical calculation of Malfliet and Tjon (Nucl. Phys. A, 127, 161,1969) as well as the experimental findings. (auth)

3851 SPIN STRUCTURE IN THE NUCLEON–DEUTERON CROSS-SECTION DEFECT. Alberi, G. (Univ., Trieste, Italy); Gregorio, M. A. Lett. Nuovo Cim.; 5: No. 8, 585-90(21 Oct 1972).

The possibility of a double spin-flip in the double scattering, taking into account all the nucleon–nucleon amplitudes, is studied, and a corrected formula is given for the total cross section defect in terms of measurable parameters. From the calculation, the symmetric part of the nucleon–nucleon total cross section is derived, and a systematically higher value is predicted for the neutron–proton total cross section. (J.F.P.)

3852 INCLUSIVE REACTION IN THE MULTIPERIPHERAL MODEL. I. π AND K DISTRIBUTIONS IN THE PIONIZATION REGION. Sakai, Sunao (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 48: No. 3, 916-26(Sep 1972).

The inclusive single particle distribution in the pionization region is investigated in the multiperipheral model. The model fits the structures of the π distribution quite well as well as the K distribution with only one parameter. The ratios $d\sigma(K)/d\sigma(\pi)$ have the k_1^2 dependence; for example they are 0.085 at $k_1^2 = 0$ and 0.25 at $k_1^2 = 1$ (GeV/c)^2. The K/π ratio becomes 0.174, which is in good agreement with the cosmic ray data (0.2 to 0.4). In the model these results are due to the kinematical reason that m_π^2 is far smaller than m_K^2. (auth)

3853 SYSTEMATICS OF SINGLE-PARTICLE SPECTRA IN PROTON–PROTON COLLISIONS. Jacob, M. (National Accelerator Lab., Batavia, Ill.); Slansky, R.; Wu, C. C. Phys. Rev., D; 6: No. 9, 2444-50(1 Nov 1972).

The shapes and scaling characteristics of the $\pi^\pm$, $K^\pm$, p, n, $\bar{p}$, and Λ spectra in proton-proton collisions may be easily understood in terms of the clustering effects observed in hadron production at present machine energies. This is the general basis for the success of the nova model. Good quantitative agreement between the model distributions and the experimental data is found. (auth)

3854 CURRENT–CURRENT INTERACTIONS OF HADRONS IN A RELATIVISTIC COMPOSITE MODEL. Plywaski, W. Boulder, Colo.; Univ. of Colorado (1972). 291p. University Microfilms Order No. 72-25,206.

Thesis.

The experimental and theoretical features of proton-proton scattering are briefly presented as background information. Some of the more prominent empirical fits and models are reviewed and compared with one another, with theory, and with experimental results. An earlier concept by Barut and Corrigan of high energy p-p scattering, based on a scalar interaction in the dynamic O(4,2) group, is extended to include a contact vector interaction of the $j^{\mu\dagger}j_\mu$ type. In this formulation the composite structure of the proton is covariantly described in terms of an infinite component wave function, $\Psi(p)$. Specifically, the scattering T-matrix elements are computed in a helicity basis. The corresponding differential scattering cross sections are evaluated for

various types of scattering, e.g., pp → pp, or → pN*, ep → eN*, Nπ → N*π*. The resulting cross sections at finite s, and in the asymptotic limit of s = ∞, are discussed and compared with experimental evidence. The slope parameter, b, is evaluated and likewise compared with experiment. Additional implications and developments are also considered. (Diss. Abstr. Int., B)

3855 SPIN–ISOSPIN FORMALISM FOR NUCLEAR SCATTERING AND PION–DEUTERON SCATTERING AT 2.01 GeV/C. Ahuja, S. D. M. Nashville; Vanderbilt Univ. (1972). 146p. University Microfilms Order No. 72-26,085.

Thesis.

An investigation was made for elastic scattering from deutrons of pions with laboratory momentum 2.01 GeV/c. The pion-nucleon scattering amplitude needed as an input is parametrized in terms of gaussian functions of momentum transfer in order to take into account explicitly the effects of spin and isospin of the colliding particles, while the angle of scattering ranges over small and intermediate values. The pion-nucleon parameters are obtained phenomenologically by employing a computer program which systematically searches values of parameters corresponding to successive minimum values of chi-square for the entire differential cross section and polarization data. Next, using this pion-nucleon scattering amplitude and the pion-deuteron differential cross section data as input to the Dean-Friar formula for pion-deuteron differential cross sections, the deuteron form-factor is determined by a chi-square minimization procedure. The success of the Dean-Friar model is measured by the extent to which the phenomenological and actual form-factors agree. (Diss. Abstr. Int., B)

Particle Invariance Principles and Symmetries

General

Refer also to abstracts 3797, 3898, and 4374.

3856 (CNRS-CPT–72-P-449) I. CONNECTED SUBGROUPS OF THE POINCARE GROUP. Bacry, H.; Combe, P.; Sorba, P. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). May 1972. 72p. Dep. NTIS (U. S. Sales Only).

The construction of the complete lattice of connected subgroups of the Poincare group was studied. The first results are presented: classification of all connected one-dimensional subgroups; connected subgroups of the L(3,1) Lorentz group; the T(4) translation group; the E(3) Euclidean group; the E(2,1) pseudo-Euclidean group; maximal connected subgroups of the Poincare group and their maximal connected subgroups. General theorems on inhomogeneous Lie algebras and useful properties are proved. A physical application concerns the motion of charged particles (tardyons, tachyons or luxons) in a homogeneous field. (France)

3857 (CNRS-CPT–72-P-461) MANY-BODY REALIZATION OF THE SCHROEDINGER ALGEBRA. Burdet, G.; Perrin, M. (Centre National de la Recherche Scientifique, Marseilles (France). Centre de Physique Theorique). May 1972. 8p. Dep. NTIS (U. S. Sales Only).

The realization, for a system of N interacting particles, of the group of all permissible transformations which leave invariant the free Schroedinger equation is given. The group, called Schroedinger group, contains the Galilei group and two additional generators which form with the Hamiltonian a subgroup isomorphic to the group SU(1,1). It is shown that the corresponding algebra furnishes a dynamical symmetry only under very restrictive constraints on the possible interactions between the particles. (France)

3858 BARYON NUMBER AND LEPTON NUMBER CONJUGATION SYMMETRY. Barry, G. W. (Univ. of California, Berkeley). Lett. Nuovo Cim.; 5: No. 5, 385-6(30 Sep 1972).

The nonexistence of protons with baryon number B = −1 is considered from the standpoint of broken symmetry. The following scheme is proposed: For every fermion there is a conjugate fermion which is identical except that it has opposite B and L, and it can have a different mass and parity. For leptons this scheme reduces to the Konopinski–Mahmoud scheme where ν_e, e^-, $\bar{\nu}_\mu$, μ^+ all have L = 1. The left-handed component of a massless four-component spinor is ν_e, while $\bar{\nu}_\mu$ is the right-handed component. (L.B.S.)

3859 TRANSFORMATION PROPERTIES OF OBSERVABLES. Neumann, H. (Univ., Marburg, Ger.). Helv. Phys. Acta; 45: No. 5, 811-19(1972).

It is well known that the position observable considered as a projection-valued measure (decision observable) is uniquely determined by its transformation properties within an irreducible representation (m ≠ 0) of the Poincaré and the Galilei group. The notion of an observable, however, has been generalized by several authors considering positive-operator-valued measures (POV measures) or corresponding subsets of the lattice of projections. Using a theorem of Neumark a theorem is proven which allows the construction of all such generalized observables with the desired transformation properties. As an example position observables in an irreducible representation of the Galilei group are discussed. It is shown that every position observable is the convolution of the usual position observable and a suitable measure in the spin Hilbert space and thus the generalized position observable is by no means unique. (auth)

3860 RECURRENT CONSTRUCTION OF IRREDUCIBLE TENSORIAL SPACES OF THE UNITARY GROUP AND FRACTIONAL PARENTAGE DECOMPOSITION OF ONE-CONFIGURATION WAVE FUNCTION. Vanagas, V. V.; Kalinauskas, R. K. (Inst. of Physics and Mathematics, Vilnyus, USSR). Teor. Mat. Fiz.; 13: No. 1, 102-7(Oct 1972). (In Russian).

A method of the recurrent construction of irreducible tensorial spaces of the unitary group U_r is proposed by means of the Clebsch–Gordan coefficients with special bases labelled by irreducible representations of the subgroups $U_{r_1} \dotplus \ldots \dotplus U_{r_k}$ ($r_1 + \ldots + r_k = r$) every one of which is in its turn reduced to the arbitrary subgroup G. The factorization of Clebsch–Gordan coefficients is given and the correspondence between the construction of tensorial spaces and the fractional parentage decomposition of one-configuration wave function is pointed out. (auth)

3861 VECTOR PARAMETRIZATION OF THE COMPLEX LORENTZ GROUP. Bogush, A. A.; Fedorov, F. I. (Inst. of Physics, Sofia). Teor. Mat. Fiz.; 13: No. 1, 67-74(Oct 1972). (In Russian).

It is shown that the complex Lorentz group can be parametrized by two independent complex three-dimensional vectors. The far-going analogy between the real and complex Lorentz groups in this parametrization is demonstrated. The general expressions for finite transformation of any irreducible finite-dimensional representations of the complex Lorentz group are obtained. (auth)

3862 NONLINEAR REALIZATIONS OF CHIRAL ALGEBRAS AND PHENOMENOLOGICAL LAGRANGIANS. Barnes, K. J.; Dondi, P. H.; Sarkar, S. C. (Queen Mary Coll., London). Proc. Roy. Soc. (London), Ser. A; 330: No. 1582, 389-415(17 Oct 1972).

Complete and general treatments are presented for the nonlinear realizations of SU(n) × SU(n) and the associated invariant Lagrangians. All transformation functions and covariant derivatives are given in strikingly simple closed forms. The physically important cases of n = 2 and n = 3 are treated in extra detail. (auth)

3863 MIXING OPERATOR FOR THE $SU_3 \otimes SU_3$ CHIRAL ALGEBRA. Buccella, F. (CERN, Geneva). pp 510-17 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

An attempt is made to extract the whole content of the SU(3) ⊗ SU(3) chiral algebra. The commutation relation for vector and axial charges, which gives a scale to the matrix elements of the axial charge is considered; the consequences of this relation sandwiched between each pair of one particle states are examined with the intent of exploiting its full content. The solution to this problem is described. (L.B.S.)

3864 LOCALIZABILITY AND THE CHIRAL $SU_n \times SU_n$ INTERACTION. Ashmore, J. F. (International Centre for Theoretical Physics, Trieste, Italy.) Lett. Nuovo Cim.; 5: No. 7, 565-6(14 Oct 1972).

It is pointed out that there is a short proof that the exponential parametrization of the chiral SU(n) × SU(n) interaction Lagrangian is localizable. (J.F.P.)

3865 NONRELATIVISTIC COMPOSITE ELEMENTARY PARTICLES AND THE CONFORMAL GALILEI GROUP. Roman, P.; Aghassi, J. J.; Santilli, R. M.; Huddleston, P. L. (Boston Univ.). Nuovo Cim.; 12A, No. 1, 185-204(1 Nov 1972).

It is shown that a recently suggested conformal generalization of the Galilei group provides a suitable framework for the algebraic description of nonrelativistic composite elementary particles with interacting (unspecified) constituents. The formal properties of the new group are clarified and its irreducible unitary representations are found. A maximal set of quantum numbers for the particles is obtained. The energy of the composite particle is quantized and a discrete spectrum emerges.

All generators in the Lie algebra are shown to have a simple direct physical interpretation. (auth)

3866 SYMMETRY PRINCIPLES IN PARTICLE PHYSICS. Emmerson, J. M. Oxford Studies in Nuclear Physics. New York; Oxford University Press (1972). 193p. $18.75.

A unified treatment of symmetry theory independent of any specific dynamical model is presented. Chapter 1 reviews the basic quantum mechanics and matrix algebra. It also gives a very general and largely elementary introduction to symmetry and invariance principles and the relationship between the two. Chapter 2 deals with the discrete symmetries, parity, charge conjugation, and time reversal, and with two combined operations, PC and PCT. The superselection rules which can be derived when a physical observable is strictly conserved in all possible interactions are discussed in Chapter 3. Chapter 4 deals with angular momentum and isospin. It develops the algebra of angular momentum starting with the generators of infinitesimal rotations and then goes on to show the connection between this and the algebra of SU(2). The necessary tensor formalism is given in detail. The results are used to discuss the G-parity and time reversal operators. Chapter 5 deals with SU(3). SU(3) is used to classify states and predict their quantum numbers. The final chapter deals with SU(6). It shows how SU(6) can be used to classify states with the help of the algebra developed in earlier chapters. (L.B.S.)

Applications (Electromagnetic and Weak)

Refer also to abstract 4194.

3867 (UT–105) $\eta \rightarrow 2\pi$ DECAY AS A TEST OF C-INVARIANT BUT P- AND T-VIOLATING STRONG INTERACTIONS. Yamaguchi, Yoshio (Tokyo Univ. (Japan). Dept. of Physics). Jun 1971. 6p. (CONF-710816–34). Dep. NTIS (U. S. Sales Only).

From International symposium on electron and photon interactions at high energies; Ithaca, NY. (23 Aug 1971).

A possible P-violating decay mode of the η meson, $\eta \rightarrow 2\pi$, is discussed. According to the new scheme of strong interactions proposed, the partial width $\Gamma(\eta \rightarrow \pi^+\pi^-)$ should be of the order of $\Gamma(\eta \rightarrow \pi^+\pi^-\pi^0)$. Moreover, an explanation is suggested why the ratio $\Gamma(\eta \rightarrow \gamma\gamma)/\Gamma(\pi^0 \rightarrow \gamma\gamma)$ does not satisfy the simple prediction $(m_\eta/m_\pi)^3/3$ by the SU(3) symmetry. Similar arguments can be made for $\eta'(958)$. (auth)

3868 CPT, T, AND FINE INTERFERENCE EFFECTS IN TWO- AND THREE-PIONIC DECAY OF NEUTRAL KAONS. Votruba, J. (Inst. of Physics, Prague). Phys. Lett.; 41B: No. 4, 485-8(16 Oct 1972).

The form of interference formulas for decay intensity of initially pure neutral K or $\overline{K}$ meson state differs slightly in the cases of CPT or T symmetry. This difference is studied for two and three-pionic decay by means of a "resolution function." A direct test of CPT (eventually T) symmetry in the decay of neutral kaons into two charged pions is proposed. (auth)

3869 SU(3) x SU(3) ALGEBRA AND THE CABIBBO ANGLE. Mathur, V. S. (Univ. of Rochester, N. Y.). Phys. Rev. Lett.; 29: No. 20, 1419-22(13 Nov 1972).

The possibility that the physically relevant currents may be different from those that satisfy the usual SU(3) ⊗ SU(3) algebra is investigated. This approach offers new insight into the nature of the Cabibbo angle. A modified soft-pion theorem for the K_{l3} decay is also obtained, which provides better agreement with the present data. (auth)

3870 LIMITS ON VARIANCES FROM SYMMETRY IN NEUTRAL KAON DECAYS. Dass, G. V.; Kabir, P. K. (European Organization for Nuclear Research, Geneva). Proc Roy. Soc. (London), Ser. A; 330: No. 1582, 331-47(17 Oct 1972).

An analysis is made of the limits on the possible departures from CP-, T-, and TCP- invariance, both in the structure of K_L and K_S states and in the decay amplitudes to $\pi\pi$ and $\pi l\nu$ channels. A small violation of the requirements of CP- and T-invariance on the structure of K_L and K_S states can be deduced under quite plausible assumptions, but there is no evidence of any other departure from the requirements of CP-, or T-, or TCP-invariance. However, the present limit for one measure δ of TCP-noninvariance is several times larger than the estimated value of the corresponding CP- and T-noninvariance parameter $\sigma = \mathrm{Re}\ K_L K_S$. Taking a conservative view of the experimental data, symmetry-violating parts of 2π decay amplitudes are limited to better than 1% for the I = 0 channel and to within a small percentage for the I = 2 channel, in relative magnitude. The corresponding limits which can be deduced for leptonic decay amplitudes are somewhat larger but there are indications that symmetry-violating amplitudes are unlikely to exceed a small percentage in relative magnitude. (auth)

3871 SCHIZON MODEL OF CP NONCONSERVATION AND $K_2^0 \rightarrow \mu + \mu$ DECAY. Rachman, N. (Tel-Aviv Univ., Israel). Lett. Nuovo Cim.; 5: No. 7, 548-52(14 Oct 1972).

A schizon model of CP violation is constructed by introducing a new phase angle. Nothing is changed in the leptonic and semi-leptonic interactions. Complex parameters are discussed for the CP-nonconserving effect in $K \rightarrow 2\pi$ decay, and a lower limit is found for the branching ratio for $K_1^0 \rightarrow \mu^+ + \mu^-$ decay. (J.F.P.)

3872 SELF-CONTAINED DETERMINATION OF THE PHASE OF η^+. Carnegie, R. K.; Cester, R.; Fitch, V. L.; Strovink, M.; Sulak, L. R. (Princeton Univ., N. J.). Phys. Rev., D; 6: No. 9, 2335-46(Nov 1972).

In a single K^0 regeneration experiment, all the parameters needed to specify the phase of the CP-noninvariant parameter η_+ have been measured concurrently. The K_{π^2} data have given the η_+ phase relative to the phase of the K_1^0 regeneration, while the regeneration phase has been measured directly using the K_{e3} charge asymmetry. Incorporated in the latter measurement is an experimentally determined correction for the effects of incoherent regeneration. The experiment yields $\arg\eta_+ = 36.2° \pm 6.1°$. (auth)

3873 CP NONCONSERVATION AND $K \rightarrow l\bar{l}\gamma$ DECAYS. Singh, S. K. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., D; 6: No. 9, 2646-9(1 Nov 1972).

A simple model which explains the observed suppression of the $K_L \rightarrow \mu^+\mu^-$ rate was used to calculate the CP-violating contribution to $K \rightarrow l\bar{l}\gamma$ decays. For $K_L \rightarrow \mu^+\mu^-\gamma$ this rate is comparable to the Dalitz-pair rate while for $K_L \rightarrow e^+e^-\gamma$ and $K_S \rightarrow l\bar{l}\gamma$ the contribution is small. (auth)

3874 NON-RELATIVISTIC AND RELATIVISTIC PHOTO-EFFECT AND COULOMB SCATTERING IN SO(4,2). Rasmussen, W. O. H. Boulder, Colo.; Univ. of Colorado (1972). 176p. University Microfilms Order No. 72-25,211.

Thesis.

The relativistic infinite component hydrogen atom wave equations of A. O. Barut and A. B. Baiquni are critically examined as generalizations of the SO(4,2) group structures of the nonrelativistic hydrogen atom and of the Dirac equation. The role of the Klein-Gordon equation for the determination of the parameters of the equation is emphasized. Scattering states are introduced into the framework of dynamical groups and relativistic infinite component wave equations. The relativistic "Coulomb"-scattering amplitude and the amplitude for photoionization of the relativistic system are calculated. The correct reduction to the nonrelativistic amplitudes is shown. Some work on the inclusion of spin into the infinite component wave equations is reported. (Diss. Abstr. Int., B)

3875 NEW FORMS OF THE DYNAMICAL ALGEBRA O(4,2) AND APPLICATIONS TO RELATIVISTIC BOUND STATES OF MAGNETIC CHARGES. Bornzin, G. L. Boulder, Colo.; Univ. of Colorado (1972). 141p. University Microfilms Order No. 72-25,141.

Thesis.

New coordinate space realizations of the Lie algebra of the dynamical group O(4,2) are used to solve the bound state problem of two particles (dyons) having both electric and magnetic charges (e, g). Schrödinger, Klein-Gordon, and Dirac formulations are used as well as covariant infinite component wave equations. The new realizations depend explicitly on the parameter of magnetic coupling $\mu = e_1g_2 - e_2g_1$, and can be used to describe systems of arbitrary spin. One particular realization mixes space and spin states in a nontrivial manner, while retaining the simple O(3)-subgroup generated by the total angular momentum $\vec{J} + \frac{1}{2}\vec{\sigma}$. A new iteration procedure is introduced for solving the Dirac equation and leads to solutions which are meaningful even for large coupling constant α. It is shown that each series of unitary O(2,1)-representations occurs depending upon whether α is below, within, or above a small range of values of order 1. Various methods for restoring O(4)-symmetry are considered, including a new method applicable to the linear Dirac equation. When applied to the $\mu = 0$ case, this method restores the O(4)-symmetry by the simple approximation of neglecting the interaction of the "small-component," negative mass states with the center of force. Connections are established between the covariant infinite component wave equation with various choices of the parameters and the symmetrized forms of the Klein-Gordon and Dirac equations. A particular choice of parameters is shown to lead to a mass spectrum applicable to both the small α case of the relativistic hydrogen atom and to the large α case of the pion considered as a bound state of two magnetic charges. (Diss. Abstr. Int., B)

Applications (Strong)

Refer also to abstract 3847.

3876 ENERGY-DEPENDENCE OF SYMMETRY BREAKING FOR TWO-BODY PROCESSES. Badier, S. (Laboratoire de Physique Theorique, Amiens, France). Phys. Lett.; 41B: No. 4, 511-16(16 Oct 1972).

Failures of symmetry predictions for two-body inelastic processes at high energy are assumed to arise from mass-difference effects in the t-channel. When applied to quark model, a new prescription for cross sections comparison is shown to agree fairly well with experiment. (auth)

3877 SU_4. IS IT A PLAUSIBLE SYMMETRY FOR HADRONS? Maiani, L. (Istituto Superiore di Sanita, Rome). pp 600-17 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

A model of weak interactions is presented, in which a new quark field p' is introduced in addition to p, n, λ. It is shown in this model that some trace of SU(4) symmetry must be present in strong interactions. The model also predicts the existence of charmed states. It is suggested that one could try to extend the usual quark model to SU(4), assigning the known particles to SU(4) multiplets and guessing the corresponding charmed particles. (L.B.S.)

3878 MATRIX SUPERPROPAGATOR OF A CHIRAL INVARIANT PION–NUCLEON INTERACTION. Davies, P. T. (Queen Mary Coll., London). J. Phys., A (London): 5: No. 10, 1479-87(Oct 1972).

A chiral SU(2) × SU(2) invariant pion-nucleon interaction is taken to first order in the meson covariant derivative. The covariant derivatives are identified in terms of the Gürsey matrix, and choosing the exponential parametrization for this the matrix superpropagator is calculated using Fourier transform techniques. (auth)

3879 EXPLORATION OF SU(3) SYMMETRY OF BARYON REGGE RESIDUES. Kayser, Boris (Northwestern Univ., Evanston, Ill.); Hayot, F. Phys. Rev., D; 6: No. 9, 2423-31(1 Nov 1972).

The SU(3) symmetry of baryon Regge poles is explored by comparing the angular distributions of backward meson-baryon reactions whose Regge exchanges should be SU(3)-related. Several indications of the symmetry are found. In particular, it is discovered that one can generate the observed highly structured angular distribution for $\pi^+p \to p\pi^+$ from the featureless one for $K^+p \to pK^+$ simply by assuming SU(3) symmetry and taking singlet-octet exchange degeneracy in K^+p scattering into account. Using the symmetry, evidence that exchange degeneracy between the Reggeized $1/2^+$ and $3/2^-$ octets is broken is found. Relevant experiments are suggested. (auth)

3880 SU(6) ASSIGNMENT FOR THE POSITIVE-PARITY NUCLEONIC RESONANCES. Cen-Tsai, C. T.; Lee, T. Y. (National Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., D; 6: No. 9, 2459-62(1 Nov 1972).

A symmetric quark-model analysis of the two-quantum excited nucleonic states is carried out. By assigning the N(1470) P_{11} and $\Delta(1690)$ P_{33} to the states in the $(56, 0^+)_{N=2}$ and the N(1860) P_{13}, N(1688) F_{15}, $\Delta(1890)$ F_{35}, and $\Delta(1950)$ F_{37} to the states in the $(56, 2^+)$ supermultiplets, it is found that the N(1780) P_{11} and the $\Delta(1910)$ P_{31} fit exceedingly well to the states in the $(70, 0^+)$, and the calculated mass value for the $J^P = 7/2^+$ nucleonic state in the $(70, 2^+)$ is comparable to that of the observed N(1990) F_{17}. (auth)

3881 POSSIBLE EXISTENCE OF $I = 5/2$ NUCLEON RESONANCES. Abramovici, A.; Hegedus, E.; Vekas, L. (Univ. of Timisoara, Rumania). Z. Phys.; 255: No. 5, 446-9(1972).

A combined SU(3)-orbital angular momentum classification scheme for baryons is reviewed. The predictions of the model concerning $I = 5/2$, $Y = 1$ resonances are compared with the existing experimental evidence of such states. (auth)

Field Theories

General

Refer also to abstract 3720.

3882 FEYNMAN–KAC FORMULA FOR EUCLIDEAN FERMI AND BOSE FIELDS. Osterwalder, Konrad; Schrader, Robert (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett.; 29: No. 20, 1423-5(13 Nov 1972).

Free, covariant Euclidean Bose and Fermi fields are defined, and their relation with the corresponding relativistic free fields is established. Using this correspondence a Feynman-Kac formula for boson-fermion models is proven. (auth)

3883 IMPROVED ENERGY-MOMENTUM TENSOR. Coleman, S. (Harvard Univ., Cambridge, Mass.). pp 526-47 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

The construction of conserved currents in general and the energy-momentum tensors in particular are first reviewed. Scale invariance is then discussed, and a new energy momentum tensor is introduced, which is believed to be an improvement on the old symmetric tensor of Belinfante. An advantage of the new tensor is demonstrated: its matrix elements are cut-off independent in renormalizable field theories. It is shown how to alter gravitation theory in such a way that the new tensor becomes the source of gravity. The experimental consequences of such an alteration are discussed. (L.B.S.)

3884 SOLVABILITY OF THE GENERALIZED SCHWINGER EQUATIONS FOR GREEN'S FUNCTIONS IN THE EUCLIDEAN FIELD THEORY. Gonchar, N. S. (Inst. of Theoretical Physics, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 8, 675-8(Aug 1972). (In Ukrainian).

Solvability of the generalized Schwinger equations is proved for Green's functions in the Euclidean field theory, and representations in terms of a functional integral are found for the solution. A random field $\xi(x)$ is constructed, so that the solution is representable in the form $\{S_n(x_1, x_2, \ldots, x_n = \int_\Omega \xi(x_1) \ldots \xi(x_n)\, dP_1\}_{n=1}^{\infty}$ where P_1 is a probability measure on a functional space Ω. (auth)

3885 ELECTROMAGNETIC FIELDS, ENERGY, AND WAVES. Magid, L. M. New York; John Wiley and Sons, Inc. (1972). 803p.

The treatment covers fields and field theory, electromagnetic field laws in free space, vector analysis, differential field laws, static fields, macroscopic fields in matter, electromagnetic energy and power, low-frequency behavior of time-varying fields, lossless transmission line theory for transverse electromagnetic fields, plane waves in lossless media, and radiation. (J.F.P.)

Quantum Field Theory

Refer also to abstracts 3702, 3721, 3754, and 3797.

3886 (DNPL/R-19, pp 129-76) QUANTUM ELECTRODYNAMICS: PRESENT STATUS OF THE THEORY. Picasso, E. (CERN, Geneva). 1971.

From Proceedings of the Daresbury study weekend; Daresbury, England (1 Oct 1971).

It is stated that this is a theory that describes a very wide range of phenomena, and its basic equations give the impression of its being very simple. Furthermore, it is an elegant theory since all observables are expressed in terms of only the coupling constant and lepton masses. If, however, a theory is to be regarded as a set of well defined mathematical relations between observables that yield a unique answer to a physical problem then quantum electrodynamics is not a theory. It does, however, give a well defined mathematical procedure for computing physical processes to any given order of approximation of physical interest. The existence of infinities remains difficult to accept, and precludes the understanding of fundamental constants such as charges and masses. This is why theorists attempt to obtain a physical regularisation of quantum electrodynamics and experimentalists are searching for possible breaking of "pure" leptonic electrodynamics. Among the reasons for possible breaking of quantum electrodynamics the locality of interaction between fields is the one most suspected of being responsible for mathematically meaningless divergent expressions that appear in theory. Quantum electrodynamics has been applied with great success over a range of distances from 5.5×10^{10} cm (about earth radius) down to subnuclear dimensions of 10^{-14} cm for the Compton wavelength of the photon. Among matters discussed are: low-energy tests of quantum electrodynamics (fine and hyperfine structure splittings, Lamb shift, muonium hyperfine splitting, positronium, measurements of the energy separation between $2s \to 2p$ levels in $(\mu\ He)^+$ ion, lepton anomalous magnetic moments); high energy tests of quantum electrodynamics (scattering experiments at high momentum transfer, scattering experiments with the e^+e^- colliding beams at Frascati, Bethe–Heitler type experiments); and search for Dirac monopoles. It is concluded that the theory is in "very good shape". It is a precise set of rules that allow very clear predictions regarding observable effects of the interaction of light with charged leptons. 82 references. (UK)

3887 FIELD THEORETIC INVESTIGATIONS IN CURRENT ALGEBRA. Jackiw, Roman. pp 97-254 of Lectures on Current

Algebra and Its Applications. Treiman, S. B. Princeton, N. J.; Princeton Univ. Press (1972).

The canonical and space-time constraints which limit the possible structure of Green's functions, commutators, and Ward–Takahashi identities are first explored. The Bjorken–Johnson–Low definition of the commutator is then discussed. Model calculations for the $\pi^0 \to 2\gamma$ problem and electroproduction sum rules are presented. A discussion of anomalies in current algebra is then given. The last topic deals with approximate scale symmetry. (L.B.S.)

3888 REGGE PHENOMENOLOGY. Phillips, R. J. N.; Ringland, G. A. (Rutherford High Energy Lab., Chilton, Eng.). pp 187-247 of High Energy Physics. Vol. V. /Burhop, E. H. S. (ed.). New York; Academic Press Inc. (1972).

High energy phenomenology, using Regge poles and related ideas, is discussed. Following an introduction on the use of Regge poles, exchange degeneracy, wrong signature zeros, and conspiracy, the following topics are discussed: finite energy sum rules, duality, Veneziano model, and Regge cut phenomenology. (L.B.S.)

3889 ANALYSIS OF PRESENT EVIDENCE ON THE VALIDITY OF QUANTUM ELECTRODYNAMICS. Gatto, R. (Univ., Padua). pp 249-63 of High Energy Physics. Vol. V. /Burhop, E. H. S. (ed.). New York; Academic Press Inc. (1972).

A review is given of the low-energy and high-energy tests of quantum electrodynamics. (L.B.S.)

3890 QUANTUM ELECTRODYNAMICS AND RENORMALIZATION THEORY IN THE INFINITE MOMENTUM FRAME. Brodsky, S. J.; Roskies, R. (Stanford Univ., Calif.). Phys. Lett.; 41B: No. 4, 517-20(16 Oct 1972).

Old fashioned (time-ordered) perturbation theory evaluated in the infinite momentum frame is shown to provide a viable calculational alternative to the usual Feynman procedure for quantum electrodynamics. The renormalization procedure can be implemented in a straightforward manner. A convenient method is introduced for automatically including Z-graph (backward-moving fermion) contributions. The electron anomalous moment was calculated through fourth order in perturbation theory in agreement with the Sommerfield–Petermann results, and representative contributions to the sixth order moment were calculated. The results agree with those of Levine and Wright. The validity of the infinite momentum method as a renormalizable calculational procedure in quantum electrodynamics gives field-theoretic parton calculations for composite particles a rigorous basis, provided that a covariant regularization procedure is used. These new techniques also show how to renormalize field theory quantized on the light cone and how to implement the Feynman gauge. (auth)

3891 PEDESTRIAN APPROACH TO QUANTUM FIELD THEORY. Harris, E. G. New York; John Wiley and Sons, Inc. (1972). 176p. $11.95.

An introduction to quantum field theory and its applications are presented. Ten chapters cover the following topics: the formalism of quantum mechanics; quantum theory of the free electromagnetic field; interaction of radiation and matter; second quantization; interaction of quantized fields; quantum electrodynamics; the theory of beta decay; particles that interact among themselves; quasiparticles in plasmas and metals; and the problem of infinities in quantum electrodynamics. Numerous problems are scattered throughout the book; answers and some solutions are given in an appendix. An appendix on relativistic wave equations is also included. (L.B.S.)

3892 STATISTICAL DESCRIPTION OF ELEMENTARY PROCESSES. II. QUANTUM FIELD THEORY. Horwitz, L. P. (Univ., Geneva). Helv. Phys. Acta; 45: No. 5, 713-33(1972).

The consequences of the assumption that the measurements set up to characterize the quantum state of certain systems do not form (nontrivially) a complete set was previously investigated in the framework of the one-particle Hilbert space. Systems of identical particles, and the structure of the associated quantum fields, are discussed. The general form of the n-body density matrices characterizing incompletely measured states is given, and a special class of observables which "carry their own incoherence" is constructed. As an illustration, a free charged Klein–Gordon field is constructed; it is shown that the field is nonlocal if the energy momentum is a nontrivial function of unmeasured variables. Coherent states are discussed, and it is shown that fields with some similarity to those of the Veneziano operator theory appear as a special case in which the spectrum of unmeasured observables corresponds to the four-fold tensor indices of space-time. (auth)

3893 AETHER THEORY AND THE FINE-STRUCTURE CONSTANT. Aspden, H.; Eagles, D. M. (National Standards Lab., Sydney). Phys. Lett.; 41A: No. 5, 423-4(23 Oct 1972).

The results of a recomputation of a previously published theory for the fine structure constant are presented. A new feature of the theory is then shown to determine the value of α^{-1} as $108\pi(8/1843)^{\frac{1}{2}}$ or 137.035 915, a figure in agreement with the observed value of 137.036 02 ± $1\frac{1}{2}$ parts per million. (auth)

3894 UNIQUENESS OF THE ENERGY DENSITY IN THE INFINITE VOLUME LIMIT FOR QUANTUM FIELD MODELS. Osterwalder, K.; Schrader, R. (Harvard Univ., Cambridge, Mass.). Helv. Phys. Acta; 45: No. 5, 746-54(1972).

Two properties of the vacuum energy E_V (for volume V) that are sufficient to ensure the existence and uniqueness of $\lim_{V\to\infty} E_V/V$ are isolated. The first property has been recently verified by Glimm and Jaffe for the $P(\varphi)_2$ quantum field model. The second property is shown to hold in a simplified $P(\varphi)_2$ model where the free field energy H_0 is replaced by the number operator N. (auth)

3895 STATISTICHESKIE METODY V FIZIKE VYSOKIKH ENERGII. (Statistical Methods in High Energy Physics). Azimov, S. A.; Chernov, G. M. Tashkent; Izdatel'stvo FAN Uzbekskoi SSR (1970). 108p.

The use of mathematical statistics is essential in high energy interactions, because of the large variations in angular, energy, and other characteristics of secondary particles produced in inelastic processes, and also because of the absence of an adequate theory of these processes. An attempt was made to systematize specific and often nonstandard methods of statistical testing of hypotheses concerning the interaction of high energy particles. Spatial angular distribution and azimuthal effects in multiple particle production were examined from the statistical viewpoint. (K.S.W.)

3896 SIXTH HILBERT PROBLEM. Niederle, J.; Tolar, J. Pokroky Mat. Fyz. Astron.; 17: No.3, 135-46(1972). (In Czech).

The sixth Hilbert problem is considered as a starting point to build and to develop axiomatically certain physical disciplines, in which mathematics plays a major role. The objectives of the recently developed quantum field theory appear to be a suitable answer to the problems outlined by Hilbert. The authors disagree with the viewpoint expressed by R. Jost, according to which such an axiomatic approach simply adds final touches to an already formulated theory; this is definitely not the case of the quantum field theory. In that connection, the formulation of various axioms and major approaches are outlined. These axioms are: consistency with the general principles of quantum physics, relativistic invariance, localization, stability of the vacuum system, and completeness. The fulfillment of the goals of the axiomatic quantum field theory is discussed, pointing out that the theory provides only a few physical predictions but those have a fundamental importance, -e.g., spin statistics, CPT theorem, analytical properties of the S matrix, dispersion relations, etc. (TTT)

3897 QUESTION OF INVARIANT RENORMALIZABILITY OF THE MASSLESS YANG–MILLS THEORY IN A MANIFEST COVARIANT APPROACH. Honerkamp, J. (CERN, Geneva). Nucl. Phys., B48: No. 1, 269-87(1972).

By introducing a classical field the generating functional of the Green's functions for the Yang–Mills theory is written as a sum of gauge invariant functionals depending on the classical field. An invariant regularization of the functionals corresponding to the class of one-loop diagrams is given so that the finite part fulfils the Ward identities automatically. (auth)

3898 EQUAL-TIME COMMUTATORS WITH IMPROVED ENERGY–MOMENTUM TENSOR. Tao Wong Tung. Teor. Mat. Fiz.; 13: No. 1, 75-82(Oct 1972). (In Russian).

In the framework of the conformal symmetry theory the equal-time commutators between the field operators and the components of the improved energy-momentum tensor introduced previously are calculated. The problem of scale dimensionality of currents as well as derivatives of fields is discussed. (auth)

3899 METHOD OF THE EXTENDED S-MATRIX IN QUANTUM FIELD THEORY. Medvedev, B. V.; Pavlov, V. P.; Polivanov, M. K.; Sukhanov, A. D. (Inst. of Mathematics, Moscow). Teor. Mat. Fiz.; 13: No. 1, 3-40(Oct 1972). (In Russian).

A general theory of extending the scattering matrix beyond the energy surface by means of introducing the dependence on functions describing arbitrary external classical object is developed. In terms of this classical functional argument the space–time description is introduced which is necessary for formulating the causality condition. The latter is imposed in the form given to it by N. N. Bogolyubov. The systematic exploitation of this principle makes it possible to construct a detailed dynamic theory. Three well-known particular cases of the choice of a classical object are considered: the function of switching-on the interaction, classical

additive term to the quantized out-field and the classical current-source. The twice extended—with respect to the field as well as to the current—S-matrix is introduced in order to establish the relations between the last two ways of extending. On the basis of this the relation between the consequences of the Bogolyubov and Lehmann–Symanzik–Zimmermann axiomatics is clarified. (auth)

3900 CONFORMALLY COVARIANT SPINOR FIELD EQUATIONS. Drew, M. S. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 50: No. 18, 2100-4(15 Sep 1972).

Conformally covariant equations for free spinor fields are determined uniquely by carrying out a descent to Minkowski space from the most general first-order rotationally covariant spinor equations in a six-dimensional flat space. It is found that the introduction of the concept of the "conformally invariant mass" is not possible for spinor fields even if the fields are defined not only on the null hyperquadric but over the entire manifold of coordinates in six-dimensional space. (auth)

3901 EXTERNAL FIELDS IN LEE–WICK THEORY. Ferretti, B. (CERN, Geneva). pp 582-99 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

It is shown that an external field can be introduced in a quantum model with indefinite metric of the type of Lee and Wick without any unitary difficulties if the ordinary computational rules are generalized. An attempt is made to introduce the discussion about local observable. It is shown that by using the device of the "dressed wave packets" a reasonable criterion of localization might be introduced by isolating the interaction effect between different localized currents. (L.B.S.)

3902 NOTE ON EXPERIMENTAL TESTS OF QUANTUM ELECTRODYNAMICS WITH ELECTRON PAIR ANNIHILATION. Tomberger, G.; Ringhofer, K. (Univ., Munich). Lett. Nuovo Cim.; 5: No. 8, 625-9(21 Oct 1972).

It is shown that a more thorough evaluation of the Kroll gauge-invariant modification of QED gives a strange behavior of the pair annihilation cross sections. This leads to the fact that at a value $\Lambda \approx E$ of the parameter Λ describing the modification where E is the energy involved, QED and modified QED give exactly the same results. Therefore, if one measures only at one energy, one cannot obtain a bound on Λ much higher than this energy using the Kroll modification. To raise the bound on Λ the measurement of the energy is essential. Also a different gauge-invariant modification with a simpler behavior is given where the energy dependence does not play such a crucial role. The differential and total cross sections for pair annihilation and Compton scattering are calculated using gauge-invariant modifications of QED. (J.F.P.)

3903 TIME-ORDERED PRODUCTS AS INDICATRICES OF WIGHTMAN FUNCTIONS. Pfaffelhuber, E. (Univ. of Wyoming, Laramie). Nuovo Cim.; 12A: No. 1, 12-20(1 Nov 1972).

For renormalizable and unrenormalizable interactions time-ordered matrix elements are defined as indicatrices of Wightman functions in momentum space, in accordance with the formal definition of T-products in co-ordinate space. The Dyson equation then automatically yields a vanishing mass renormalization. The indicatrix formalism can be extended to equal-time commutators of fields and currents. The resulting Schwinger terms do not violate causality. The usual spectrum conditions imply that a perturbation analysis for Wightman functions should not generate any divergences. This result is confirmed by model calculations. Therefore, the formalism seems suitable to produce a divergence-free and local quantum field theory from the very beginning. (auth)

3904 CONSTRUCTION AND UNIQUENESS OF SUPER-PROPAGATORS FOR SCALAR MASSLESS FIELDS. Krause, Fr.; Scheunert, M. (Univ., Bonn). Nuovo Cim.; 12A: No. 1, 221-40(1 Nov 1972).

A method to construct superpropagators in nonpolynomial Lagrangian theories is proposed generalizing in a certain sense the method of "minimal singularities" which has been used to construct the superpropagator in the exponential case. Some of the momentum-space properties of the resulting superpropagators are discussed, and a mathematical lemma which can be used to study the uniqueness of the construction is derived. (auth)

3905 QUANTIZATION OF FREE TACHYON FIELDS AND POSSIBILITY OF SUPERLUMINAL URBARYON MODEL. Hamamoto, Shinji (Toyama Univ., Japan). Progr. Theor. Phys. (Kyoto); 48: No. 3, 1037-51(Sep 1972).

On the basis of the physical assumptions that the field is composed only of the normal part, and that the theory is invariant under Lorentz-, C-, P- and T-transformations, quantization of various free tachyon fields is investigated. It is shown that the relation between spin and statistics is reversed. The possibility of a superluminal urbaryon model is also pointed out. (auth)

3906 POSITION-SPACE PROPAGATORS AND A THEORY OF FUNCTIONAL FIELDS RELEVANT TO THE DUAL-RESONANCE MODELS. Minami, Masatsugu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 974-1004(Sep 1972).

For the construction of a field theory for dual-resonance models, the Green's functionals for the hadronic "strings" are introduced as natural extensions of the conventional Feynman propagators in position space. To this end, some descriptions on quantum mechanics for a two-dimensional medium along the line of Dirac's action principle are given. The functional propagators assume both boson and fermion fields together with the functional equations they satisfy. A rough sketch is attempted of the Lagrangian field theory for the boson fields; and some schemes of interaction are outlined in terms of the inhomogeneous equations whose elementary solutions are just the propagators. Examples given are the cases in which the general n-point Veneziano amplitude and the amplitudes associated with one-loop diagrams are formally derived. (auth)

3907 FUNCTIONAL METHODS IN QUANTUM THEORIES WITH DERIVATIVE COUPLING AND SPIN-ONE PARTICLES. Mouton, J. O. Los Angeles; Univ. of California (1972). 95p. University Microfilms Order No. 72-25,817.

Thesis.

The material resolves certain questions of quantum factor ordering and manifest Lorentz covariance in the perturbation expansion of theories with time derivatives or terms acting as time derivatives in the interaction Hamiltonian. There is a single unifying theme: the results are derived with the aid of functional (or path) integration and the use of special functional differential operators. An expository account of path integrals is presented, with special emphasis on the features which often recur in the subsequent work. A considerable amount of such background material was deemed necessary in order to properly prepare the way for the later work. Thus, it required only a minimal increase in scope to make a fairly comprehensive history. The techniques of functional integration are applied to Yang-Mills field theories and to a class of nonrelativistic theories of similar structure. A well known theorem due to Lee and Yang which bears on the manifest covariance of field theories in a perturbation expansion is rederived and applied in the context of functional integrals. The results are that the Yang-Mills theory does indeed preserve a manifestly covariant appearance in every order of the pertubation series; in other words, this theory then possesses covariant Feynman rules. The issue of quantum factor ordering is found to be important in the physical systems under consideration. The work, however, shown to be correct, even when no particular ordering prescription is given. Because of an ambiguity in the precise form of the path integral when factor ordering is important, the matter of ordering is investigated using other functional means. Special functional differential operators due to Hori are employed to resolve these questions satisfactorily and to establish a procedure for implementing an arbitrary ordering prescription in the quantum Hamiltonian and Lagrangian in a fashion consistent with the results. (Diss. Abstr. Int., B)

3908 NONANALYTIC INTERACTIONS IN SCALAR QUANTUM FIELD THEORY: A PERTURBATION TREATMENT USING FUNCTIONAL INTEGRATION. Wilson, D. E. Columbus, Ohio; Ohio State Univ. (1972). 138p. University Microfilms Order No. 72-27,140.

Thesis.

A formulation of perturbation theory is developed, for the real scalar field ϕ in self-interaction, which allows the use of a nonanalytic function for the interaction term of the Lagrangian and reduces to the customary Feynman–Dyson perturbation expansion in the case of integer power interactions. (Diss. Abstr. Int., B)

3909 CONSISTENT DESCRIPTION OF HIGHER-SPIN FIELDS. Hurley, W. J. (Syracuse Univ., N. Y.). Phys. Rev. Lett.; 29: No. 21, 1475-7(20 Nov 1972).

A generalization of the scalar product of the Dirac theory is proposed which together with a recently described generalization of the Dirac equation leads to a simple description of a massive ($m > 0$), spin-s relativistic field. This theory avoids the difficulties of parity doubling, indefinite metric, and negative energies in the second-quantized formalism, while preserving the consistency and causality of the wave equation in an external electromagnetic field. (auth)

Gravitation and General Relativity

Refer also to abstracts 3454, 3457, 3710, and 3711.

3910 RADIATIVE CORRECTIONS TO THE ELECTRON-GRAVITON VERTEX. Delbourgo, R.; Phocas-Cosmetatos, P.

(Imperial Coll. of Science and Tech., London). Lett. Nuovo Cim.; 5: No. 5, 420-2(30 Sep 1972).

The lowest-order electromagnetic corrections to the electron-graviton vertex are studied, following the same field-theoretic procedure used for the photon-graviton vertex. Detailed expression for the form factors are given. It is pointed out that there are no anomalies in the identities for the trace of the canonical stress tensor, provided the sea-gull graphs are included in the analysis. (L.B.S.)

3911 VECTOR POTENTIAL AND QUADRATIC ACTION. Lanczos, C. (Dublin Inst. for Advanced Studies). Found. Phys.; 2: No. 4, 271-85(Oct 1972).

Einstein's linear Lagrangian is replaced by a Lagrangian which is quadratic in the curvature quantities (gauge invariance). The hypothesis is made that the basic metrical field is highly agitated (due to periodic boundary conditions) thus establishing a submicroscopic basic lattice structure of the space-time world which, however, is macroscopically isotropic. All consequences follow from these assumptions. The "free vector" of Einstein's theory (void of physical significance and used for the normalization of the reference system) is no longer free but of physical significance. It becomes subject to the wave equation and the Lorentz condition. It can thus be identified with the electromagnetic vector potential. Although the present investigation does not go beyond the linear approximation, the contours of a universe of maximum rationality emerge. (auth)

3912 EFFECT OF A PERES GRAVITATIONAL WAVE ON SYNCHROTRON RADIATION. Pargamanik, L. E.; Dimanshtein, F. A. (Kharkov State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 8, 1375-6(Aug 1972). (In Russian).

It had previously been proposed by the present authors that gravitational waves might be detected by the change in the radiation of relativistic charges. The verifying of this possibility is considered by a precise solution of Einstein's equations (the A. Peres wave, 1959), and with refining the relation between such a radiation change and the energy of the charge which interacts with the gravitational wave. (K.S.W.)

3913 TWO-BODY PROBLEM IN THE THEORY OF DIRECT GRAVITATIONAL INTERACTION. I. Zhdanov, V. I.; Piragac, K. A. (Inst. of Theoretical Physics, Kiev). Acta Phys. Pol., B3: No. 5, 585-98(1972). (In Russian).

The problem of two gravitating bodies is considered in terms of a direct interparticle action. The action functional is given in a mathematically correct form. The equations following from the action principle contain both retarded and advanced potentials, however with the given functional the theory may easily be reformulated for only retarded interactions. The existence and uniqueness theorem is proved under certain conditions, provided the initial functions are given on some finite interval. (auth)

3914 TWO-BODY PROBLEM IN THE THEORY OF DIRECT GRAVITATIONAL INTERACTION. II. Zhdanov, V. I.; Piragac, K. A. (Inst. of Theoretical Physics, Kiev). Acta Phys. Pol., B3: No. 5, 599-619(1972). (In Russian).

A circular motion of two gravitating bodies is considered. The interaction is described by means of the Fokker action. Particular attention is paid to the problem of stability. When speeds are sufficiently small the circular motion is found unstable. The system of the first approximation is considered for rather general form of the Fokker action. The theorem concerning stability of the system is proved for unperturbed retardations. (auth)

3915 CAUSAL INDEPENDENCE. Avishai, Y.; Ekstein, H. (Argonne National Lab., Ill.). Found. Phys.; 2: No. 4, 256-70 (Oct 1972).

Causal independence of the simultaneous positions and momenta of two distinguishable particles in nonrelativistic physics and causal independence of events in two relatively spacelike regions of space-time in relativity are analyzed and discussed. At this review causal independence is formulated in a general and operational way, and the inferences drawn from it are summarized in nonrelativistic quantum mechanics, classical relativistic point mechanics, quantum field theory, and classical field theory. Special attention is given to the open question of the relation between local independence and commutativity in quantum field theory. (auth)

3916 POINCARE'S RELATIVITY OF ACCELERATION AND THE MACH-EINSTEIN DOCTRINE. (A HISTORICAL-CRITICAL STUDY). Treder, H. J. (Zentralinstitut fuer Astrophysik, Potsdam, Ger.). Monatsber. Deut. Akad. Wiss. Berlin; 13: No. 9, 664-75(1971). (In German).

The relativity of acceleration and Neumann's alpha body; the Mach-Einstein doctrine and inertia-free dynamics; the generalized Newton axiom, and the Mach-Poincaré group, as well as Einstein's principle of general relativity, are treated. Newton's question about the masses inducing inertial forces is answered by Einstein's theory of general relativity through the assumption of physical reality with respect to the metric field itself. Relativistic inertia-free mechanics, as developed according to the Mach-Einstein doctrine, demonstrates however that the heavy masses of the cosmos induce inertia resistance. (H.B.G.)

3917 MINIMAL SIZE OF PARTICLES IN GENERAL THEORY OF RELATIVITY. Markov, M. A.; Frolov, V. P. (Lebedev Inst. of Physics, Moscow). Teor. Mat. Fiz.; 13: No. 1, 41-61(Oct 1972). (In Russian).

The problem of minimal size of particle in general theory of relativity is considered. It is shown that the mass of neutral particle vanishes when the size of the particle tends to zero. The point limit turns out to be impossible in the case of the particle with the electric charge. Minimal sizes of the particle connected with its charge are discussed. The impossibility of the transition to the point limit in the Papapetrou model is proved. It is shown that the extent of particle in general theory of relativity does not lead to the breaking of causality, in contrast to the extent of the particle introduced in the Euclidean space. The problem of the equality of the complete (i.e. inert) and the gravitational mass is discussed as the condition under which gravitational interaction plays a role of regularizor. (auth)

3918 KLEIN-GORDON EQUATION IN RIEMANNIAN SPACE. Bondarev, A. P.; Stanyukovich, K. P. Teor. Mat. Fiz.; 13: No. 1, 140-2(Oct 1972). (In Russian).

The solution of the Klein-Gordon equation with dependence on the radius a(t) is obtained in the Friedmann closed space metric. The noneuclidicity of the metric and its time-dependence are shown to bring about the damping of wave functions in the first order with respect to small quantity $H/\omega_0 \sim 10^{-40}$ and the decrease of frequency in the second order. (auth)

3919 SOME RESTRICTIONS ON THE ENERGY-MOMENTUM TENSOR OF A SPIN-½ PARTICLE. Hayashi, K. (Max-Planck Inst. for Physics and Astrophysics, Munich). Lett. Nuovo Cim.; 5: No. 7, 529-34(14 Oct 1972).

It is found that the requirement that the dynamical energy-momentum tensor (as the source tensor of gravitation) be symmetric enormously restricts the type of possible gravitational interactions of nucleons and leptons. (J.F.P.)

3920 KOMAR SUPERPOTENTIAL EXPRESSION FOR THE TRAUTMAN CONSERVATION LAW GENERATOR OF GENERAL RELATIVITY. Moss, M. K. (North Carolina State Univ., Raleigh). Lett. Nuovo Cim.; 5: No. 7, 543-7(14 Oct 1972).

It is shown that the Trautman expression for the differential form of the conservation law generator and the Komar superpotential expression are intimately related in a fundamental way for all cases in which the more restrictive conditions of the Trautman expression are valid. A generally covariant superpotential representation of the Trautman expression is naturally obtained. And a new and different expression for the differential form of the conservation laws of general relativity is suggested. This suggested divergence can be shown to include the Trautman expression in its entirety and a physically significant subset of the Komar mathematical identity. It is shown that the Trautman expression can be expressed in the form of a Komar superpotential for any symmetry property admitted by a solution of the Einstein field equations which is describable as a killing vector field. (J.F.P.)

3921 SECOND-ORDER RECURRENT SPACE-TIMES IN GENERAL RELATIVITY. McLenaghan, R. G. (Univ. of Waterloo, Ont.); Thompson, A. H. Lett. Nuovo Cim.; 5: No. 7, 563-4 (14 Oct 1972).

The most general space-time possessing a second-order recurrent curvature tensor which is not also a recurrent curvature tensor is presented. (J.F.P.)

3922 DOES THE AXIAL VECTOR CURRENT INFLUENCE SPACE-TIME? Hayashi, K. (Max-Plank-Institut fuer Physik und Astrophysik, Munich). Lett. Nuovo Cim.; 5: No. 10, 739-44(4 Nov 1972).

It is argued that the axial vector current along with the energy-momentum tensor of the spin-½ baryons and leptons may influence the space-time structure through the spin angular-momentum tensor contributing to gravitational sources. (J.F.P.)

Scattering Theory

Refer also to abstracts 3764, 3899, 3906, 4177, and 4183.

3923 (ITF-72-97-E) ANALYTIC CONTINUATION OF DAMA. II. Bugrii, A. I.; Enkovskii, L. L.; Kobylinskii, N. A.; Prognimak, A. B. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 24p. Dep. NTIS (U. S. Sales Only).

The analytic continuation of DAMA in one and in two variables is carried out. The singularities appearing in the amplitude as well as the mechanism which generates them are studied. The expression for the double spectral function is derived and its properties are investigated. (auth)

3924 NARROW RESONANCE AND TACHYON APPROXIMATIONS OF THE SCATTERING AMPLITUDE. Bugrij, A. I.; Yenkovszkii, L. L.; Kobylinskii, N. A. (Inst. for Theoretical Physics, Kiev). Lett. Nuovo Cim.; 5: No. 5, 389-92(30 Sep 1972).

An attempt is made to construct a class of dual amplitudes with Mandelstam analyticity, which shares the attractive features of the narrow-resonance Veneziano amplitude while possessing good analytic properties and contain broad resonances. The unitarization procedure of the amplitude written in the tachyon approximation is illustrated. (L.B.S.)

3925 REGGE-BEHAVED DUAL AMPLITUDES SATISFYING THE MANDELSTAM REPRESENTATION. Bugrii, A. I.; Yenkovszkii, L. L.; Kobylinskii, N. A. (Inst. for Theoretical Physics, Kiev). Lett. Nuovo Cim.; 5: No. 5, 393-7(30 Sep 1972).

A condition which is sufficient for the Regge behavior of dual amplitudes with Mandelstam analyticity is presented. The condition also yields the exponential decrease of the (su)-term and the polynomial boundedness of the spectral function. (L.B.S.)

3926 TESTS OF THE EQUAL-PHASE ASSUMPTION IN DOUBLE RESONANCE PRODUCTION. Dohohue, J. T.; Plaut, G. (Univ., Nice). Phys. Lett.; 41B: No. 4, 495-8(16 Oct 1972).

A set of $(2J_1 + 1)^2$ tests are proposed of the hypothesis that all helicity amplitudes in the quasi-two-body reaction $0^- + 1/2^+ \to J_1 + J_2$, $J_2 \gg 3/2$, have the same phase. These tests are that certain bilinear forms in the observable statistical tensors $t^{M_1M_2}_{L_1L_2}$ with L_1 and L_2 even must vanish. They may be applied to experiments on an unpolarized target where no weak parity-violating decays are observed. (auth)

3927 STATISTICAL DESCRIPTION OF ELEMENTARY PROCESSES. I. SINGLE-PARTICLE THEORY. Horwitz, L. P. (Univ., Geneva). Helv. Phys. Acta; 45: No. 5, 701-12(1972).

As a basis for the formulation of a statistical description of elementary processes, it is assumed that the measurements set up to characterize the quantum state of certain systems may not form (nontrivially) a complete set. The consequences of this assumption for the structure of quantum mechanical states and their evolution in time is investigated, and some aspects of scattering theory are discussed. A representation in terms of an overcomplete family of states is suggested by this structure, and its time evolution is studied. The phenomena of induced dispersion and broken symmetries are discussed. (auth)

3928 RIGOROUS CONSTRAINTS, BOUNDS, AND RELATIONS FOR SCATTERING AMPLITUDES. Yndurain, F. J. (Universidad Autonoma, Madrid). Rev. Mod. Phys.; 44: No. 4, 645-67(Oct 1972).

A review of rigorous results on scattering amplitudes at low, intermediate, and high energies is presented. The emphasis is on constraints that can be compared with experiment. Some new results are presented, in particular the existence of absolute bounds for inelastic processes, constraints for odd pion-pion waves, and a lower bound for scattering amplitudes at positive t. Most of the results rest only upon unitarity and what is popularly known as axiomatic analyticity, but there are a few cases where larger analyticity domains are needed. (auth)

3929 NORMAL THRESHOLD APPROXIMATION TO ANALYTICITY AND MANDELSTAM REPRESENTATION. Svec, M. (McGill Univ., Montreal). Czech. J. Phys.; 22: No. 10, 871-3 (1972).

Normal threshold approximation to analyticity of a two-body scattering amplitude formulated in the space C_3 of independent complex variables $\hat{s}$, $\hat{t}$, $\hat{u}$ and restricted by the assumption of polynomial boundedness in all three variables leads to a three-dimensional integral representation which is shown to reproduce Mandelstam representation on the complex plane $\hat{s} + \hat{t} + \hat{u} = \sum_{i=1}^{4} m_i^2$. (auth)

3930 FROM THE ASYMPTOTIC CONDITION TO THE CROSS SECTION. Martin, Philippe A. (Univ. of Denver). Helv. Phys. Acta; 45: No. 5, 794-801(1972).

A relation is established in the framework of algebraic scattering theory between the time-dependent formalism and the cross section: the formula concerning "scattering into cones" is shown to hold essentially as a consequence of the asymptotic condition. (auth)

3931 ON A RECENT PAPER OF AMREIN, GEORGESCU, AND JAUCH. Chandler Colston; Gibson, A. G. (Univ. of New Mexico, Albuquerque). Helv. Phys. Acta; 45: No. 5, 734-7(1972).

Condition (D) of a recent paper of Amrein, Georgescu and Jauch is shown to be a consequence of their conditions (θ) and (A). (auth)

3932 APPROXIMATE METHOD OF SOLVING THE INVERSE SCATTERING PROBLEM. Vasilevskii, A. S.; Vasilevskii, L. S.; Zhirnov, N. I. (Moscow Pedagogical Inst.). Teor. Mat. Fiz.; 13: No. 1, 108-19(Oct 1972). (In Russian).

On the basis of the generalized WKB-method approximate algorithms are developed for reconstructing the scattering potential from the known energy or angular momentum dependence of phase shifts. Calculation formulas are deduced, which correspond to the zeroth and the second (with respect to the Planck constant) approximations of the generalized WKB-method. (auth)

3933 EXCHANGE DEGENERACY AND DUALITY IN A GENERALIZED INTERFERENCE MODEL. Logan, R. K. (Univ. of Toronto). Can. J. Phys.; 50: No. 17, 2033-6(1 Sep 1972).

A generalized interference model is considered in which the Pomeron and the other Regge poles are built in the sense of a FESR bootstrap from both the resonance and background part of the low energy scattering amplitude. A test is developed of strong exchange degeneracy on the background part of the low energy scattering amplitude through the use of FESR. The restrictions through FESR imposed by exchange degeneracy are shown to be weaker than those of duality. The amount of duality breaking in $\bar{B}B$ in the absence of exotic mesons is related to the ratio of NN or πN, P', and ρ Regge residues. (auth)

3934 IMPACT PARAMETER REPRESENTATIONS. Kamal, A. N. (Rutherford High Energy Lab., Chilton, Eng.). Can. J. Phys.; 50: No. 16, 1862-75(15 Aug 1972).

A discussion of the Glauber and Blankenbecler-Goldberger impact parameter representation for the scattering amplitude is presented with emphasis on the wave function approach. The treatment makes clear the relation between the approximations made to derive either of the two amplitudes. Both on-energy-shell and off-energy-shell scatterings are treated. A derivation of the two representations in momentum space is presented bringing out the relation between the approximations in a coordinate space treatment and the momentum space treatment. (auth)

3935 USE OF NEGATIVE-ENERGY TIME-LIKE STATES. Szegoe, K. (Hungarian Academy of Sciences, Budapest). Acta Phys. Austr.; 35: No. 1-2, 32-9(1972).

It is shown that the analytic continuation of the quasi-elastic scattering amplitude into the different channels can lead to negative energy time-like states. Its advantages and difficulties are discussed. (auth)

3936 INTEGRAL REPRESENTATION OF A GREEN'S FUNCTION OF HARMONIC OSCILLATORS. Berendt, G.; Weimar, E. (Freie Univ., Berlin). Lett. Nuovo Cim.; 5: No. 8, 613-19(21 Oct 1972).

It is pointed out that harmonic oscillator-type systems are of interest in connection with the algebraic formulation of Veneziano-type amplitudes. It is further noted that relativistic quark models in the oscillator approximation lead to Wick-rotated scattering amplitudes which have a similar structure to matrix elements of the resolvent operator of a four-dimensional harmonic oscillator. An algebraic derivation of matrix elements of that type is given using the full SU(n) symmetry of the n-dimensional harmonic oscillator. (J.F.P.)

3937 FINITENESS OF NONDERIVATIVE NONPOLYNOMIAL LAGRANGIANS. Keck, B. W.; Taylor, J. G. (King's Coll., London). J. Phys., A (London); 5: No. 10, 1473-8(Oct 1972).

It is shown how to achieve a finite (and unitary and causal) S matrix for a large class of nonderivative nonpolynomial Lagrangians. (auth)

PHYSICS (LOW-TEMPERATURE)

3938 (COO-1569-93) EXPERIMENTAL AND THEORETICAL STUDIES IN SOLID STATE AND LOW TEMPERATURE PHYSICS. Annual Progress Report for 1972. (Minnesota Univ., Minneapolis. Inst. of Tech.). Sep 1972. Contract AT(11-1)-1569. 51p. Dep. NTIS.

ALUMINUM—superconducting properties of films of
COPPER ALLOYS—Cu-base-Pr, nuclear cooling using $PrCu_6$
CRYSTALS—properties of quantum, theoretical research on
HELIUM, SUPERFLUID—quantum hydrodynamics of
HELIUM ISOTOPES He-3—quantum properties of solid, research on
HELIUM ISOTOPES He-3—He-3–He-4, critical behavior near lambda curve of liquid
HELIUM ISOTOPES He-4—He-3–He-4, critical behavior near lambda curve of liquid
LIQUIDS—properties of quantum, theoretical research on
LOW TEMPERATURE PHYSICS—research program at Minnesota Univ.
NIOBIUM NITRIDES—superconducting properties of films of
PRASEODYMIUM ALLOYS—Cu-base-Pr, nuclear cooling using $PrCu_6$
SUPERCONDUCTIVITY—research program at Minnesota Univ. (D.L.C.)

Superfluidity

Refer also to abstract 4379.

3939 EXPERIMENT ON DISSIPATION IN HELIUM FILM FLOW. Cannon, W. C.; Chester, Marvin; Jones, B. K. (Univ. of California, Los Angeles). J. Low Temp. Phys.; 9: No. 3-4, 307-29(Nov 1972).

Experiments are reported in a double-bucket system with a view to examining the application to helium film flow of recent predictions regarding the exponential relationship between the superflow speed and the chemical potential gradient driving force. The theory is found to be generally commensurate with experimental results with a notable exception. One of the parameters, which is predicted to be constant, is experimentally found to have a definite temperature dependence, which is given in detail. Also, evidence with regard to the height dependence of film thickness in the dissipative regime is reported. It is found that this thickness appears to be determined by the mean distance to the two bath levels. (auth)

3940 ANGULAR DISTRIBUTION OF PHONONS RADIATED FROM A HEATED SOLID INTO LIQUID ^{4}He. Sherlock, R. A.; Wyatt, A. F. G.; Mills, N. G.; Lockerbie, N. A. (Univ. of Nottingham, University Park, Eng.). Phys. Rev. Lett.; 29: No. 19, 1299-1301(6 Nov 1972).

The angular distribution of phonons radiated from a cleaved (100) face of a sodium fluoride crystal, pulse heated to $T \sim 0.5$ K, into liquid ^{4}He at $T < 0.1$ K was measured. The distribution shows a sharp peak superimposed on a low-amplitude background extending to ~35° to the normal. The peak width is consistent with a critical cone $\theta_c = 4.25°$ calculated under the assumption of conservation of phonon wave vector parallel to the interface. (auth)

3941 PRECISE MEASUREMENT OF EFFECTIVE MASS OF POSITIVE AND NEGATIVE CHARGE CARRIERS IN LIQUID HELIUM II. Poitrenaud, J.; Williams, F. I. B. (CEN de Saclay, Gif-sur-Yvette, France). Phys. Rev. Lett.; 29: No. 18, 1230-2 (30 Oct 1972).

The resonance of charge carriers trapped under the surface of He II is observed at 200 MHz. The effective masses are found to be $m_+^* = (45 \pm 2)m_4$ and $m_-^* = (76 \pm 2)m_4$, where m_4 is a bare ^{4}He mass. The ionic radii are deduced to be $R_+ = 6.0 \pm 0.1$ Å and $R_- = 11.4 \pm 0.1$ Å. (auth)

3942 INTERPRETATION OF RECENT RESULTS ON ^{3}He BELOW 3 mK: A NEW LIQUID PHASE. Leggett, A. J. (Univ. of Sussex, Eng.). Phys. Rev. Lett.; 29: No. 18, 1227-30(30 Oct 1972).

It is demonstrated that recent NMR results in ^{3}He indicate that, at 2.65 mK, the liquid makes a second-order transition to a phase in which the "spin–orbit" symmetry is spontaneously broken. The hypothesis that this phase is a BCS-type phase in which pairs form with l odd, $S = 1$, $S_z = \pm 1$ leads to reasonable agreement with both NMR and thermodynamic data, but involves some difficulties as to stability. (auth)

Superconductivity

3943 (BNL-17222) COMPARATIVE STUDY OF SUPERCONDUCTING COMPOSITE CONDUCTORS WITH FILAMENTS OF A-15 COMPOUNDS. Suenaga, M.; Sampson, W. B. (Brookhaven National Lab., Upton, N. Y.). [nd]. 5p. (CONF-720908-16). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY. (19 Sep 1972).

Composite superconductors consisting of fine filaments of Nb_3Sn, V_3Ga, and V_3Si in bronze matrixes (Cu–Sn, Cu–Ga, and Cu–Si, respectively) were made by the solid-state diffusion method. The conductors have identical geometry and consist of 19 filaments approximately 25-μm diameter filaments in a 0.25-mm diameter wire. The superconducting properties of these composite wires are compared as well as their susceptibility to mechanical damage. (auth)

3944 (COO-1569-91) PAIR-FIELD SUSCEPTIBILITY OF SUPERCONDUCTORS. Anderson, J. T.; Carlson, R. V.; Goldman, A. M.; Tan, H-T. (Minnesota Univ., Minneapolis. School of Physics and Astronomy). 1972. Contract AT(11-1)-1569. 12p. (CONF-720833-20). Dep. NTIS.

From 13th international conference on low temperature physics; Boulder, CO. (20 Aug 1972).

Current–voltage characteristics were measured in Al/AlO lead tunneling junctions biased from a constant current source. Quasiparticle currents were computed. The linear variation of the reciprocal of the square root of the dynamic conductance with temperature indicates that the dominant tunneling mechanism is specular transmission of electrons. Dc Josephson current, peak current, peak voltage, and magnetic field dependences were determined. Experimental results are in quantitative agreement with the theory of Scalapino (Phys. Rev. Lett. 24: 1052(1970) and Takayama (Prog. Theor. Phys. (Japan) 46: 1 (1971)) except in the immediate vicinity of T_c. (D.L.C.)

3945 (UCRL-73860) EXPERIMENTS WITH ALUMINUM BONDED Nb_3Sn. Henning, C. D.; Nelson, R. L.; Leichter, H. L.; Ward, C. O. (California Univ., Livermore. Lawrence Livermore Lab.). 17 Aug 1972. 10p. (CONF-720908-9). Dep. NTIS.

From fourth international conference on magnet technology; Upton, NY. (19 Sep 1972).

Experiments with Nb_3Sn tapes have shown that adiabatic stability is relatively unchanged by bonding aluminum rather than copper to a superconductor. In the cusp-coil configuration with edge cooling, test magnets of 0.5-in.-wide tape underwent a superto normal transition when the perpendicular fields reached 19 kG. Operation in superfluid helium increased the allowable perpendicular field to 23 kG. When connected in a solenoid configuration the conductors closely approached short-sample performance. All tests were reproducible and somewhat sensitive to charging rate. Face cooling increased the coil performance to the cryogenic stability limit and decreased rate sensitivity. It is concluded that aluminum is best used for nucleate boiling stabilization in conjunction with face cooling. Measurements of the bearing strength of high-purity aluminum indicate that stresses greater than 8000 psi are permissible under insulation strips. Tensile strengths were measured and a model formulated for design and fracture loads. (auth)

3946 PROPERTIES OF SUPERCONDUCTING ALLOYS CONTAINING PARAMAGNETIC IMPURITIES WITH LOCAL STATES WITHIN THE GAP. Chaba, A. N.; Singh Nagi, A. D. (Univ. of Waterloo, Ont.). Can. J. Phys.; 50: No. 15, 1736-46 (1 Aug 1972).

Using the Green's function given by Shiba or Rusinov, several properties of superconducting alloys containing paramagnetic impurities and having local states within the gap were calculated. At temperatures equal to zero, near zero, and near T_c, the analytic expressions for the order parameter and various thermal properties are given. For various values of ϵ_0 (the normalized position of a local state with a single impurity), the dependence of the zero-temperature order parameter and the zero-temperature critical field on the inverse spin-flip collision time are computed. Further, for various values of ϵ_0, the impurity-concentration dependence of the zero-temperature order parameter, the transition temperature, the zero-temperature critical field, and the jump in specific heat at T_c are computed. Some of the results would also apply to superconducting Kondo systems. (auth)

3947 VOLUME CHANGE AT THE SUPERCONDUCTING TRANSITION OF LEAD AND ALUMINUM. Ott, H. R. (Tech-

nische Hochschule, Zurich). J. Low Temp. Phys.; 9: No. 3-4, 331-43(Nov 1972).

The volume change at the magnetic field-induced transition from the superconducting to the normal state was measured on single crystals of lead and aluminum between 0.3 K and T_c. From these data, the pressure dependence of the critical field H_c, of the critical temperature T_c, and of the electronic specific heat coefficient γ was deduced. In lead, the results are in good agreement with theoretical calculations by Carbotte, where strong-coupling effects are taken into account. $\partial \ln \gamma / \partial \ln V = 3.1 \pm 0.8$ was found, where V is the volume. The measurements on aluminum giving $\partial \ln \gamma / \partial \ln V = 3 \pm 4$ are consistent with results derived from thermal expansion experiments. (auth)

3948 FLUXOID PINNING IN SUPERCONDUCTORS BY A PERIODIC ARRAY OF MAGNETIC PARTICLES. Autler, S. H. (Univ., Lausanne, Switzerland). J. Low Temp. Phys.; 9: No. 3-4, 241-53(Nov 1972).

A two-dimensional array of ferromagnetic particles on the surface of a thin type-II superconductor in a transverse magnetic field is assumed. With a particle at the center of each fluxoid, the pinning force P and critical current increase ΔJ_c due to the particles are calculated. General expressions without arbitrary parameters are given for P and ΔJ_c as functions of magnetic field strength and the characteristics of the superconductor and the particles. For broad ranges of conditions, values of P and ΔJ_c greater than 10^{-7} dyn and 10^5 A/cm^2 result, and for certain physically realistic sets of conditions, $P > 10^{-6}$ dyn and $\Delta J_c > 10^6$ A/cm^2 are predicted. The above effects should be readily observable. An experiment for setting up the assumed conditions is proposed and discussed in some detail. (auth)

3949 ORIGIN OF RESONANCE STATE IN SUPERCONDUCTORS. Shibata, Fumiaki; Machida, Kazushige (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 48: No. 2, 701-2(Aug 1972).

Fetter (Phys. Rev., 140: A1921(1965)) observed a resonance scattering near the Fermi surface. A mechanism for such resonance is proposed in which the resonance is caused by a classical spin-type potential. The matrix Λ^1 is replaced by $\Lambda = \Lambda^1 + \lambda_0 \tau_0$, and equations are solved for the R and T matrices. It is concluded that Fetter's resonance in a superconductor is caused by the spin-dependent potential without introducing any off-diagonal potential. (D.L.C.)

3950 PRESSURE DEPENDENCE OF THE SUPERCONDUCTING TRANSITION TEMPERATURE FOR VANADIUM. Smith, T. F. (Univ. of California, La Jolla). J. Phys., F (London); 2: No. 5, 946-56(Sep 1972).

The superconducting transition temperature T_c for vanadium was determined as a function of hydrostatic pressure up to 24 kbar for a number of samples covering a wide range of resistance ratios. T_c is observed to increase linearly for all of the samples at a rate (mean value $0.62 \pm 0.03 \times 10^{-5}$°K bar^{-1}) which is almost independent of its initial value and which is considerably smaller than reported previously. The difference is attributed to the use of better hydrostatic pressure conditions in the present investigation. The measured $\partial T_c / \partial P$ for V, Nb, and Ta are shown to be thermodynamically consistent with measurements of the volume difference between the superconducting and normal states. These measured $\partial T_c / \partial P$ are also compared with the results of a recent theoretical calculation. The intrinsic T_c for vanadium is estimated to be 5.46 ± 0.02°K. The variation of the zero-pressure T_c values of a function of resistance ratio yields an energy gap anisotropy parameter $\langle a^2 \rangle$ which is consistent with that obtained from direct measurements of the gap. (auth)

3951 LOW-TEMPERATURE CRYSTAL MODIFICATION AND THE SUPERCONDUCTIVE TRANSITION TEMPERATURE OF $NbSe_2$. Yamaya, K.; Sambongi, T. (Hokkaido Univ., Sapporo). Solid State Commun.; 11: No. 7, 903-5(1 Oct 1972).

From the study of the pressure dependence of the superconductive transition temperature and the Hall coefficient, it is concluded that $NbSe_2$ has a low-temperature, low-pressure crystal modification, with a negative Hall coefficient and a lower transition temperature compared with the 2H modification stable at room temperature. (auth)

3952 SUPERCONDUCTIVITY OF Hf–Ta AND Ta–W ALLOYS UNDER PRESSURE. Gey, W.; Koehnlein, D. (Univ., Karlsruhe, Ger.). Z. Phys.; 255: No. 4, 308-14(1972).

Measurements on ten binary alloys of the body-centered cubic part of the 5d-alloy series Hf–Ta and Ta–W yield a linear relationship between the derivatives of the quantity g both with respect to pressure and to valence electron concentration, where g is defined by $T_c \propto \theta \exp(-1/g)$. This result agrees with observations on alloys of the 4d-series, Zr–Nb and Nb–Mo. It is concluded that for these alloys composed from the central part of the 4d and 5d transition series, the interaction responsible for superconductivity is less subject to complications than for other transition metals and is probably governed by the electronic density of states. Data on the variation of the transition temperature with concentration in Hf–Ta alloys are included. (auth)

3953 STUDIES ON THE FORMATION OF V_3Ga AND V_3Si SUPERCONDUCTING COMPOUNDS BY A NEW DIFFUSION PROCESS. Tachikawa, K.; Yoshida, Y.; Rinderer, L. (National Research Inst. for Metals, Tokyo). J. Mater. Sci.; 7: No. 10, 1154-60(Oct 1972).

Diffusion between vanadium and Cu–20 at. % Ga alloy or Cu–20 at. % Si alloy was studied. An intermetallic compound, V_3Ga, is formed easily by the selective diffusion of gallium from the Cu–Ga alloy to the vanadium. V_5Si_3 and V_3Si are formed also by selective diffusion from the Cu–Si alloy. Copper scarcely dissolves either in V_3Ga, V_5Si_3, or V_3Si. Copper is not effective for enhancing the formation of V_3Si unlike the case of V_3Ga. A large superconducting critical current density J_c, is obtained in the V_3Ga formed at temperatures below 700°C while a much smaller J_c is obtained in the V_3Si formed at 800°C. Changes in J_c due to the heat treatment can be interpreted by the grain growth of the compounds. (auth)

3954 IMPROVEMENTS IN OR RELATING TO SUPERCONDUCTING CABLES. Taylor, M. T. (to Central Electricity Generating Board). British Patent 1,284,531. 9 Aug 1972. Filed 9 May 1968.

Reference is made to superconducting power transmission cables and other conductors for carrying alternating currents using superconducting materials. The type of cable described is claimed to fulfil technical requirements and to be economic to construct and operate. It is formed at least partly of a hard type-II superconducting material consisting either of Nb–Zr alloy, having 10 to 40% Zr by weight, or Mo–Re alloy having 30 to 50% Re. This material has a backing of Cu or Al on one face and a Nb coating on the other face. The Nb–Zr alloy may contain up to 10% by weight of Ta in place of Nb, or 2% Y, or 10% Hf. An interlayer may be provided between the Cu or Al and the superconducting material, consisting of a mechanically deformable material, such as Nb, that bonds to the backing material and the superconducting material without forming brittle compounds. The cable may comprise two concentric tubes, the inner tube having the type-II superconductor on its outer surface, with the Nb coating on the outside of the superconductor, and the outer tube having the superconductor on its inner surface, with the Nb coating on the inside of the superconductor. Alternatively, each tube may be formed of a backing layer of Cu or Al supporting the superconducting material, the latter having on the face opposite to the backing layer a coating of Nb, and interlayers being provided. (UK)

3955 IMPROVEMENTS IN OR RELATING TO METHODS OF MAKING ELECTRICAL SUPERCONDUCTORS OF NIOBIUM–ZIRCONIUM MATERIAL AND TO SUPERCONDUCTORS MADE THEREBY. Taylor, M. T. (to Central Electricity Generating Board). British Patent 1,284,532. 9 Aug 1972. Filed 11 Aug 1969.

A method is described for fabricating a Nb–Zr alloy superconductor copressed with Cu. The Cu forms a backing to carry the current in the event of any small incursions into a normal, as distinct from superconducting, state. It also forms a mechanical support and exerts a protective function. Al may also fulfil similar functions. The Nb–Zr alloy employed contains preferably 10 to 40% Zr; such alloys are ductile and can be coprocessed with Cu by mechanical working. The alloy is enclosed completely in Cu and then mechanically worked with the Cu surface temperature below 100°C and the alloy at 500 to 850°C. This is possible since the thermal conductivity of the alloy is poor and the thermal contact between the alloy and the Cu is also poor; the alloy and the Cu may be heated to the required temperature and then quenched in water, the quenching cooling the Cu but not the alloy. The mechanical working is conveniently an extrusion process, and after the first extrusion the Cu is bonded to the alloy and the material can then be cold worked. The Nb–Zr alloy may have up to 10% Hf by weight in place of Nb, or up to 2% Y, or 10% Ta. An interlayer may be provided between the Nb–Zr alloy and the Cu, comprised of a mechanically deformable material that bonds both to the Cu and the alloy without forming brittle compounds. The alloy may also be coated with Nb before coprocessing with the Cu, and in this case the Cu may be removed from one face of the Nb-coated alloy to leave a Nb surface exposed, or a Nb coating may be applied to the surface. (UK)

3956 METHOD OF PRODUCING RELIABLE SUPERCONDUCTING WEAK LINKS. Bruck, A. (Univ. of Manchester, Eng.). J. Phys., E (London); 5: No. 11, 1047-9(Nov 1972).

A new method for making reproducible and mechanically stable superconducting weak links is described. The method is based on

the fact that the critical current of a weak link, in the form of a superconducting filament inside a semiconductor, or a superconducting film on a semiconducting substrate, can be controlled by diffusion into the semiconductor. (auth)

3957 SELFCONSISTENT TREATMENT OF FLUCTUATIONS IN SUPERCONDUCTORS BEYOND THE HARTREE APPROXIMATION. Bray, A. J.; Rickayzen, G. (Univ. of Kent, Canterbury, Eng.). J. Phys., F (London); 2: No. 5, L109-13(Sep 1972).

An approximation for the superconducting order parameter in one- and two-dimensional systems is proposed which interpolates between the Hartree–Fock approximation well above T_c and the Hartree approximation well below T_c. The approximation is shown to be exact at both high and low temperatures for the one-dimensional case. A peak in the specific heat just below T_c is predicted in both one and two dimensions. (auth)

3958 STABILITY OF COMPOSITE SUPERCONDUCTORS IN FAST-PULSED MAGNETIC FIELDS. Martinelli, A. P. (Institut fuer Plasmaphysik, Garching, Ger.). pp 1108-25 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The stability of composite superconducting materials for high-field applications under the influence of external transverse fast-pulsed magnetic fields is studied in a measuring setup where the pulsed field (amplitude 50 to 10,000 Oe, risetime ranging from about 500 to 5 μsec, and in the form of both periodic and aperiodic functions) is superposed on a stationary magnetic field (0 to 40 kOe). Several tests are made on short samples and small inductively and noninductively wound coils (Nb–Zr, Nb–Ti, stabilized and unstabilized, with superconducting single-core or multifilamentary structure). The pulsed fields just necessary to quench the sample (threshold values) are measured (for different field rise times) as a function of the superposed stationary field, for different ratios of the stabilizing metal to superconductor and for different values of the transport current and induced magnetization currents. The magnetization current decay caused by the pulsed fields is observed at different values of the transport current. The shielding of the pulsed field due to the stabilizing substrate is calculated, and so is the heat generated in the substrate by the eddy currents produced by the changing field. The calculations are related to the experimental results on the composites and unstabilized materials. The results suggest limits and applications of such composites to superconducting coils subjected to external pulsed fields with the stated rise times and frequencies (e.g., in a number of plasma machine configurations). (auth)

3959 AC LOSSES IN COMPOSITE SUPERCONDUCTING WIRES. Salmon, D. R.; Catterall, J. A. (National Physical Lab., Teddington, Eng.. pp 1148-65 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

Measurements were made at 4.2°K of the losses in filamentary composites of niobium in copper carrying transport currents of up to 70 A at frequencies in the range 50 to 800 Hz. Critical currents and B–H loops were also measured. The experimental results can be accounted for on the basis of a physical model in which the composite wire behaves as a solid superconductor. The effect on the losses due to twisting the composite wires was also investigated. (auth)

3960 RADIATION DAMAGE IN Nb–Ti SUPERCONDUCTING WIRES. Hassenzahl, W. V.; Rogers, J. D.; Laquer, H. L.; Armstrong, W. C. (Los Alamos Scientific Lab., N. Mex.). pp 1193-1204 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

Commercial copper-clad Nb–Ti superconducting wires were irradiated with 14-MeV protons and with γ's and neutrons produced by 20- to 25-MeV electrons stopping in a thick tantalum target. Reduced short-sample characteristics and permanent resistivity were observed in some materials. Samples were irradiated both at room temperature and in liquid He. Some of the damage observed in the samples irradiated in liquid He annealed out when the samples were brought to room temperature for several hours. (auth)

3961 COHERENT QUASIPARTICLE EXCITATION IN A TYPE-II SUPERCONDUCTOR IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Sugahara, Masanori (Yokohama National Univ., Ohoka, Japan). Phys. Rev. Lett.; 29: No. 19, 1318-21 (6 Nov 1972).

Structures are observed in the current-voltage characteristics of a type-II superconductor in crossed fields. This effect can be explained as due to coherent quasiparticle excitation when the electromagnetic fields satisfy excitation conditions. (auth)

3962 INFLUENCE OF THE CURRENT-PHASE RELATIONSHIP ON THE I–V CHARACTERISTIC OF SUPERCONDUCTING WEAK LINKS. Auracher, F.; Van Duzer, T. (Univ. of California, Berkeley). Appl. Phys. Lett.; 21: No. 10, 515-18(15 Nov 1972).

I–V characteristics with and without hysteresis are calculated for various current-phase relations. It is shown that the shape of the current-phase relation has a significant influence on the shape of the I–V characteristic and the amount of hysteresis in it. (auth)

3963 SUPERCONDUCTIVITY OF INDIUM ANTIMONIDE. Vitovskii, N. A.; Vikhlii, G. A.; Mashovets, T. V.; Ryvkin, S. M. (Ioffe Inst.of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 6: No. 2, 342-3(Aug 1972).

Translated from Fiz. Tekh. Poluprov.; 6: No. 2, 400-1(Feb 1972).

A superconducting surface state was induced in InSb by a special surface treatment. The critical temperature is 4.9°K, the critical magnetic field H_c is 12.5 kG, and the critical current I_c at 4.2°K in zero field is within the range 5 to 10 mA. The temperature dependences of H_c and I_c are shown. (D.L.C.)

3964 EFFECT OF ALTERNATING CURRENT ON THE STEADY-STATE CHARACTERISTICS OF A JOSEPHSON JUNCTION. Bondarenko, S. I.; Verdyan, A. I.; Demyanov, L. D. (Physical-Technical Inst. of Low Temperatures, Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 17: No. 5, 823-6(Nov 1972).

Translated from Zh. Tekh. Fiz.; 42: No. 5, 1039-42(May 1972).

Using an alternating current it is possible to control the current–voltage characteristic of a Josephson junction. It is possible to reduce or completely suppress the hysteresis, to vary the critical current, and to change the shape of the resistive section. An explanation of the observed phenomenon is given. It can be used in the investigation and application of weak superconductivity. (auth)

3965 GINSBURG–LANDAU THEORY OF FLUCTUATIONS IN SUPERCONDUCTORS OF SMALL DIMENSIONS. Parkinson, J. B. (Univ. of Manchester, Eng.). J. Phys., F (London); 2: No. 5, 966-71(Sep 1972).

For superconductors of very small size the terms in the Ginzburg–Landau free energy which describe spatial fluctuations can be neglected. The remaining terms are treated exactly and comparison with Marčelja's theory [Phys. Lett., 28A: 180-1(1968)] shows a slight reduction in the magnitude of the fluctuations. The specific heat is also calculated, and an extension to one-dimensional specimens presented. (auth)

3966 VOLTAGE PULSES PRODUCED BY THE MOTION OF VORTICES IN SUPERCONDUCTORS. Park, J. G. (Imperial Coll. of Science and Tech., London). J. Phys., F (London); 2: No. 5, 957-65(Sep 1972).

It is shown how the results obtained by Clem (Phys. Rev., B1: 2140-55(1970)) for the voltage pulse produced by the motion of an isolated vortex across a slab of superconductor may, for a certain configuration of the potential leads, be derived rather directly for a superconductor with a vanishingly small penetration depth λ. It is then shown that this result is generally valid for superconductors even when λ is finite: it is unchanged as long as the vortex does not pass too close to the contacts or, more generally, when the London equations are obeyed (the case considered by Clem). It is suggested that one is not generally justified in calculating the resultant voltage for a moving array of vortices, by superposing pulses, when a pulse is calculated for each vortex as though it moved across the slab in the absence of the others. (auth)

3967 APPLIED MAGNETIC FIELD VS CRITICAL CURRENT DENSITY CHARACTERISTICS OF SUPERCONDUCTING Nb–Ti–Zr AND Nb–Ti–Ge SHEETS. Kitada, M.; Doi, T. (Hitachi Ltd., Tokyo). J. Jap. Inst. Metals; 36: No. 9, 891-6(Sep 1972). (In Japanese).

Applied magnetic field (H) vs critical current density (J_c) characteristics of Nb–(55 to 75) Ti–5 Zr and Nb–(55 to 65) Ti–1, Ge sheets aged at 350 to 500°C were measured at 4.2°K to examine the anisotropic effect. Nb–(55 to 75) Ti–5 Zr sheets showed the largest critical current density at a composition of 65 at. % Ti. For the sheet aged at 350°C for 25 h, $J_c(\parallel)$ and $J_c(\perp)$, critical current densities where the magnetic field was applied parallel and perpendicular to the sheet plane were 6.3×10^4 and 3.4×10^4 A/cm^2, respectively, at 80 kOe. The ratio of $J_c(\parallel)/J_c(\perp)$ of Nb–Ti–Zr sheet decreased with increasing Ti concentration,

and the minimum $J_c(\|)/J_c(\perp)$ ratios obtained for Nb–55 Ti–5 Zr and Nb–75 Ti–5 Zr sheets were 4.5 and 1.3, respectively. The aging time making the critical current density maximum for Nb–Ti–Ge sheets was shorter than that of Nb–Ti–Zr sheets. Moreover, the critical current density of Nb–Ti–Zr sheets at high magnetic fields was considerably larger than that of Nb–Ti–Zr sheets. For the Nb–60 Ti–1 Ge sheet aged at 500°C for 10 hr, $J_c(\|)$ and $J_c(\perp)$ were 1.1×10^5 and 6.1×10^4 A/cm^2, respectively, at 80 kOe. (auth)

Equipment and Devices

Refer also to abstracts 2599–2603, 2637, 3081, 3154, 3158, 3168–3182, 3328–3331, 3954, 3955, 4273, and 4274.

3968 (BNL–17233) OPTIMIZATION OF GAS-COOLED SUPERCONDUCTING MAGNET LEADS. A METHOD FOR GENERAL MATERIALS. Goodzeit, C. L. (Brookhaven National Lab., Upton, N. Y.). 18 Sep 1972. 13p. Dep. NTIS.

A method is presented for calculating the length to area ratio of current leads for superconducting magnets that will minimize the heat loss caused by the lead. The method does not assume that the material obeys the Wiedemann–Franz relation; therefore, calculations can be made for ultrahigh-purity metals. Sample calculations for such materials are made, and it is shown that it is possible to effect a refrigeration saving over that required for W–F materials. (auth)

3969 NUCLEAR COOLING IN $PrCu_6$. Andres, K.; Bucher, E. (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Low Temp. Phys.; 9: No. 3-4, 267-89(Nov 1972).

Nuclear adiabatic demagnetization experiments were performed in the Van Vleck paramagnet $PrCu_6$ in order to determine the very-low-temperature nuclear magnetic properties of this material and to test its efficiency as a very low-temperature refrigerator. It is found that a temperature of 2.7 mK can be reached from an initial temperature of 40 mK and an initial field of 20 kOe. Susceptibility and specific heat measurements above 2.7 mK indicate the presence of both nuclear quadrupole and exchange interactions. The transition of an antiferromagnetically ordered state among the Pr nuclei is expected to occur below 2.7 mK. (auth)

PHYSICS (NUCLEAR)

3970 (COO-1674-71) TECHNICAL PROGRESS REPORT, OCTOBER 1, 1971–SEPTEMBER 30, 1972. Fano, U. (Chicago Univ., Ill.). 1 Oct 1972. Contract AT(11-1)-1674. 8p. Dep. NTIS.

A summary is presented of research in: channel interaction and spectroscopy, theory of angular distributions of reaction products, theory of close coupling eigenchannels, barrier effects in molecules and crystals, and effective interactions and RPA method. (15 references) (D.L.C.)

3971 (LBL-666) NUCLEAR CHEMISTRY ANNUAL REPORT, 1971. (California Univ., Berkeley. Lawrence Berkeley Lab.). May 1972. Contract W-7405-eng-48. 397p. Dep. NTIS.

Research progress is reported on: nuclear structure and nuclear reactions; chemical and atomic physics; physical, inorganic, and analytical chemistry; and instrumentation and systems development. Separate abstracts were prepared for each of the 4 sections. Thesis abstracts, a list of 1971 publications, and author index are included. (M.C.G.)

For abstracts of individual sections see: 2386, 2551, 3972, and 4344.

3972 (LBL-666, pp 1-175) NUCLEAR STRUCTURE AND NUCLEAR PROPERTIES. May 1972.

In Nuclear chemistry annual report, 1971.

ALUMINUM-27—neon-20 reactions up to 200 MeV, excitation functions for direct, (E)
ASTATINE-211—energy levels of, calculation of three-particle and four-particle one-hole, (T)
BARIUM-143—energy-level transitions in, (E)
BARIUM-145—energy-level transitions in, (E)
BISMUTH-209—proton reactions with, shell and pairing effects on fission probability for, (T)
—alpha reactions with, shell and pairing effects on fission probability for, (T)
CALCIUM-40—carbon-12 reactions (C-12,He-6) at 62.6 MeV, helium-6 spectra from, (E)
—alpha reactions (α,2α) at 90 MeV, triple differential cross sections for, (E)
—alpha elastic scattering at 40.7 to 72.3 MeV, backward angular distributions for, (E)
—helium-3 reactions (He-3,αp) at 4.2 to 22 MeV, excitation function for, (E)
CALCIUM-42—alpha elastic scattering at 40.7 to 72.3 MeV, backward angular distributions for, (E)
CALCIUM-44—alpha reactions (α,2α) at 90 MeV, triple differential cross sections for, (E)
—alpha elastic scattering at 40.7 to 72.3 MeV, backward angular distributions for, (E)
CALCIUM-48—alpha elastic scattering at 40.7 to 72.3 MeV, backward angular distributions for, (E)
CARBON-12—carbon-12 reactions (C-12,Be-8) at 62.6 MeV, beryllium-8 spectra from, (E)
—carbon-12 reactions (C-12,He-6) at 62.6 MeV, helium-6 spectra from, (E)
CERIUM-138—energy levels from cerium-140 (p,t) reactions, model analysis of, (E/T)
CERIUM-140—energy levels from cerium-142 (p,t) reactions, model analysis of, (E/T)
—energy-level transitions in, (E)
CHLORINE-35—helium-3 reactions (He-3,α) at 4.2 to 22 MeV, excitation function for, (E)
CHLORINE-37—helium-3 reactions (He-3,2n) and (He-3,2p) at 4.2 to 22 MeV, excitation functions for, (E)
COBALT-53—proton decay of isomeric, proton spectra from, (E)
DYSPROSIUM-150—alpha decay of, α energies and half-life for, (E)
DYSPROSIUM-151—alpha decay of, α energies and half-life for, (E)
DYSPROSIUM-152—alpha decay of, α energies and half-life for, (E)
ERBIUM-152—alpha decay of, α energies and half-life for, (E)
ERBIUM-153—alpha decay of, α energies and half-life for, (E)
ERBIUM-154—alpha decay of, α energies and half-life for, (E)
FISSION—droplet model calculation of barriers for
GOLD-197—proton spallation at 5 GeV, α spectra from fragments of, (E)
—proton reactions with, shell and pairing effects on fission probability for, (T)
—alpha reactions with, shell and pairing effects on fission probability for, (T)
HELIUM-3—helium-3 reactions (He-3,t) at 45 to 60 MeV, triton spectra from, (E)
HELIUM-4—deuteron elastic scattering at 15 to 45 MeV using polarized beam, vector analyzing power for, (E)
HOLMIUM-151—alpha decay of ground-state and isomeric, α energies and half-lives for, (E)
HOLMIUM-152—alpha decay of ground-state and isomeric, α energies and half-lives for, (E)
HOLMIUM-155—alpha decay of, α energies and half-life for, (E)
IODINE-136—energy-level transitions in, (E)
LANTHANUM-144—energy-level transitions in, (E)
LANTHANUM-145—energy-level transitions in, (E)
LEAD-207—alpha reactions with, shell and pairing effects on fission probability for, (T)
LEAD-206—proton reactions with, shell and pairing effects on fission probability for, (T)
—alpha reactions with, shell and pairing effects on fission probability for, (T)
LEAD-208—oxygen-16 inelastic scattering at 104 MeV, interference effects in, (E)
—oxygen-16 reactions (O-16,N-15) and (O-16,O-17) at 104 MeV, particle spectra from, (E)
—proton reactions with, shell and pairing effects on fission probability for, (T)
—alpha reactions with, shell and pairing effects on fission probability for, (T)
LITHIUM-7—carbon-12 reactions (C-12,He-6) at 62.6 MeV, helium-6 spectra from, (E)
LUTETIUM-175—alpha reactions with, shell and pairing effects on fission probability for, (T)
MOLYBDENUM-105—energy-level transitions in, (E)
NICKEL ISOTOPES—oxygen-16 reactions at 60 MeV, Q-value dependence of one- and two-nucleon transfer, (E/T)
NICKEL-56—energy level of, isospin-forbidden particle decay of first T = 2, (E)
NUCLEAR REACTIONS—evaporation of complex fragments in, method for calculation of, (T)
NUCLEAR STRUCTURE—semiempirical level density formula with shell and pairing effects
—deformation in excited nuclei, disappearance of shell effects with excitation energy in calculation of, (T)
NUCLEAR THEORY—Thomas–Fermi calculation of temperature-dependence of nuclear properties
—droplet model calculations of beta stability
NUCLEI, INTERMEDIATE—proton reactions (p,t) with deformed, analysis of indirect processes in, (T)
OXYGEN-16—energy levels from carbon-12 (C-12,Be-8) reactions, (E)
PALLADIUM-115—energy-level transitions in, (E)
PLUTONIUM-240—fission of isomeric, γ spectra from spontaneous, (E)
POTASSIUM-39—helium-3 reactions (He-3,α) and (He-3,2α) at 4.2 to 22 MeV, excitation functions for, (E)
PRASEODYMIUM-151—energy-level transitions in, (E)
RHENIUM-185—alpha reactions with, shell and pairing effects on fission probability for, (T)
RHENIUM-187—alpha reactions with, shell and pairing effects on fission probability for, (T)
RHODIUM-110—energy-level transitions in, (E)
RHODIUM-112—energy-level transitions in, (E)
RUTHENIUM-109—energy-level transitions in, (E)
RUTHENIUM-111—energy-level transitions in, (E)
SILICON-28—proton elastic scattering at 17 to 29 MeV using polarized beam, analyzing powers for, (E)
SULFUR-32—helium-3 reactions (He-3,p) at 4.2 to 22 MeV, excitation function for, (E)
TANTALUM-181—proton spallation at 5 GeV, α spectra from fragments of, (E)
—alpha reactions with, shell and pairing effects on fission probability for, (T)
TECHNETIUM-107—energy-level transitions in, (E)
TECHNETIUM-109—energy-level transitions in, (E)
TERBIUM-149—alpha decay of, α energies and half-life for, (E)
THORIUM-232—proton spallation at 5 GeV, α spectra from fragments of, (E)
THULIUM-153—alpha decay of, α energies and half-life for, (E)

THULIUM-154—alpha decay of ground-state and isomeric, α energies and half-lives for, (E)
THULIUM-169—alpha reactions with, shell and pairing effects on fission probability for, (T)
TRANSACTINIDE ELEMENTS—search for naturally-existing superheavy, (E)
—fission of superheavy, shell-model calculation of decay widths and probabilities
TUNGSTEN-182—alpha reactions with, shell and pairing effects on fission probability for, (T)
TUNGSTEN-183—alpha reactions with, shell and pairing effects on fission probability for, (T)
TUNGSTEN-184—alpha reactions with, shell and pairing effects on fission probability for, (T)
URANIUM—proton spallation at 5 GeV, α spectra from fragments of, (E)
URANIUM-238—alpha inelastic scattering at 50 MeV, differential cross sections and deformation parameters for, (E)
—proton reactions (p,t) at 25 MeV, analysis for second-order processes in, (E)
—alpha reactions (α,2n) at 25 MeV with fission isomer excitation, search for γ transitions from, (E)
YTTERBIUM-155—alpha decay of, α energies and half-life for, (E)
ZIRCONIUM ISOTOPES—oxygen-16 reactions at 60 MeV, Q-value dependence of one- and two-nucleon transfer, (E/T)
ZIRCONIUM-99—energy-level transitions in, (E) (J.W.R.)

3973 TABULATION OF GAMMA-GAMMA DIRECTIONAL-CORRELATION COEFFICIENTS FOR STATES OF HIGH ANGULAR MOMENTA. **Haustein, P. E. (Brookhaven National Lab., Upton, N. Y.); Taylor, H. W.; McPherson, R.; Fairchild, R.** Nucl. Data, Sect. A; 10: No. 4-5, 321-467(May 1972).

The coefficients in the gamma-gamma directional-correlation function $W(\theta) = 1 + A_2(\delta)P_2(\cos\theta) + A_4(\delta)P_4(\cos\theta)$ where δ is the mixing ratio for γ_1 or γ_2, are tabulated for 845 selected spin sequences of the form $I_1 \xrightarrow{L_1L_1'} I_2 \xrightarrow{L_2} I_3$ or $I_1 \xrightarrow{L_1} I_2 \xrightarrow{L_2L_2'} I_3$ for states of high angular momenta. Integral spin values have been limited to the range $5 \rightarrow 20$, half-integral spins to the range $7/2 \rightarrow 39/2$. In most cases L_1 and L_2 are either 1 or 2, L_1' and L_2' are $L_1 + 1$ and $L_2 + 1$, respectively. Sequences for which $A_4(\delta)$ is identically zero have the quantity $F_4(\delta)$ tabulated in its place. When used in conjunction with the angular momentum symmetry properties of the directional-correlation coefficients, $F_4(\delta)$ allows the calculation of $A_4(\delta)$ for more than 350 additional sequences. (auth)

3974 NUCLEAR RESEARCH REPORT: COMPILATION OF ON-GOING RESEARCH PROJECTS. MAY 1972. **Doron, Ted A. (ed.).** Columbus, Ohio; Nuscience Publications (1972). 205p. $38.00.

A comprehensive compilation of nuclear research in progress is presented. Titles of projects are arranged according to country and research center and authors are listed as well as any necessary descriptors. A subject and author index is provided. A partial listing of high-energy physics projects is included. (J.W.R.)

Neutron Interactions with Matter

Refer also to abstract 3824.

3975 (BNWL-B-201) MODIFICATIONS TO THE FLANGE CODE FOR WATER SCATTERING KERNELS. **Thomsen, D. H. (Battelle Pacific Northwest Labs., Richland, Wash.).** Jul 1972. Contract AT(45-1)-1830. 10p. Dep. NTIS.

The FLANGE code is the code approved to process ENDF/B thermal neutron scattering data. It was found that the integration scheme used to calculate the scattering cross sections for hydrogen in water gives errors of up to 1-½ percent in the total scattering cross section and up to 3-½ percent in the transport cross section for energies above 0.6 eV. The scattering cross section also has a scatter of approximately one percent for different energies. Improvements to the integration were made which reduced the systematic error and scatter in the cross section to less than 0.2 percent. Changes were also made in the code which speed up the calculation by as much as a factor of three yet give values identical to those of the slower calculation. The FLANGE code was used with ENDF/B data to produce a scattering kernel for hydrogen in water for the BMC Monte Carlo code. This kernel consistently gave a harder spectrum than calculations using the THERMOS code with a kernel also calculated using the FLANGE code with the same data. It has been determined that this discrepancy is explained by the integration scheme used in the FLANGE code. A new kernel for the BMC code has been generated using the improved version of the FLANGE code. The modified FLANGE code is designed to give good cross sections for hydrogen in water. If other moderators are being calculated, an examination of the FLANGE integration scheme should probably be made for that particular moderator. (auth)

3976 (CONF-721018-5) DATA ACTIVITIES OF THE RADIATION SHIELDING INFORMATION CENTER. **Roussin, R. W.; Trubey, D. K.; Maskewitz, Betty F. (Oak Ridge National Lab., Tenn.).** 1972. 9p. Dep. NTIS.

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The Radiation Shielding Information Center (RSIC) is involved in many data activities, with most emphasis being placed on nuclear cross section data. Through cooperation with various agencies, RSIC assists in improving the adequacy of basic evaluated cross section data and packages and distributes various types of data libraries useful in radiation transport analysis. The emphasis of the effort is on the improvement of calculational tools available to the shielding analyst. (auth)

3977 (INDC(CCP)-25/U) PROPOSALS ON RENDA: A WORLD-WIDE COMPILATION OF REQUESTS FOR NEUTRON DATA MEASUREMENTS FOR REACTORS. **Usachev, L. N.; Bobkov, Yu. G. (International Nuclear Data Committee).** Aug 1972. 5p. (CONF-720723-1). Dep. NTIS (U. S. Sales Only).

From 5th meeting of INDC, Vienna, Austria (17 Jul 1972).

Two proposals are advanced with respect to RENDA, the compilation of requests for neutron data measurements. The first proposal suggests that the title be changed to include the word "Evaluations." The second proposal is that what is understood under the required accuracy of each of the requested values be defined fully and strictly. (L.T.W.)

3978 (LA-DC-72-1010) ANISOTROPY OF PHOTON EMISSION IN TRANSPORT CALCULATIONS. **Dudziak, Donald J.; Bosler, Gerald E. (Los Alamos Scientific Lab., N. Mex.).** 1972. 15p. (CONF-721018-2). Dep. NTIS.

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

Photon production data, including angular distributions, presently exist in the ENDF for several materials. The LAPH series of codes were developed to compute Legendre moments of multigroup photon-production matrices. Initial investigations were made into the effects of photon-emission anisotropy on flux distributions. Coupled neutron-photon transport calculations were performed with the DTF-IV code. Comparisons of P_3 scattering calculations, using P_0 and P_2 photon-production matrices, were made for a fission source in 5 meters each of sodium and concrete. Total fluxes between P_0 and P_2 approximations differed by up to 11% in photon groups containing anisotropically emitted photons. (auth)

3979 (LA-DC-72-1142) MEASUREMENTS OF NEUTRON CROSS SECTIONS WITH NUCLEAR EXPLOSIVES. **Diven, B. C. (Los Alamos Scientific Lab., N. Mex.).** 1972. 12p. (CONF-721108-2). Dep. NTIS.

From PNE panel meeting; Vienna, Austria (26 Nov 1972).

Techniques have been developed to use nuclear explosives as sources of neutrons for nuclear cross-section measurements. Engineering methods have been developed to allow use of these explosions to make measurements of quality comparable to conventional laboratory measurements but on materials that cannot be measured with conventional methods. Nuclear explosions were used to measure fission cross sections of more than 20 nuclides and capture cross sections of a half dozen. Many of these measurements could not have been made by conventional means. Several preliminary measurements were required to develop the data recording techniques and four experiments have been conducted in the interval 1965–1969 in which extensive data have been collected. (auth)

3980 (RISO-262) SIGMA MASTER TAPE, A MULTI-GROUP CROSS SECTION LIBRARY. **Hvidtfeldt Larsen, A. M. (Danish Atomic Energy Commission, Risoe, Research Establishment).** Apr 1972. 50p. Dep. NTIS (U. S. Sales Only).

The SIGMA MASTER TAPE is a cross section library for use in reactor physics calculations. It is generated from the UK Nuclear Data Library by the program SIGMA and contains the materials available in the UK Library, version 1968. The cross sections are given in a 76-group structure. The method of calculation and the contents of the tape are described together with the format and the use on the Borroughs B6700 computer. (auth)

3981 (TKK-F-A-157) ON THE VARIANCE REDUCTION TECHNIQUES IN MONTE CARLO SOLUTIONS OF NEUTRON TRANSPORT PROBLEMS. **Kalli, H. (Helsinki Univ. of Technology, Otaniemi (Finland)).** Sep 1971. 33p. INIS.

The variance reduction techniques of the Monte Carlo calculations are divided into two principal classes. The techniques in the first class are based on different choices of the random walk process used for generating single histories. The techniques in

the second class are designed to reduce the variance for (small) sets of unindependent histories. The techniques in both sets can and should be combined in the calculations. All the techniques discussed are applicable with a different choice of estimator. (auth)

3982 EIGENFUNCTIONS EXPANSION METHOD FOR NEUTRON WAVE PROPAGATION. PROBLEM II. PSEUDO-MODE CALCULATION. Yamagishi, Tomejiro; Sekiya, Tamotsu. Technol. Rep. Osaka Univ.; 22: 1-9(Feb 1972).

A homogeneous form of Boltzmann equation with a cut-off cross section in the neutron wave propagation problem is solved by the eigenfunctions expansion method in an infinite system. By numerical calculations of the continuum contributions, the effect of cold neutron streaming on the neutron amplitude is revealed. (auth)

3983 EFFECTS OF ANISOTROPIC HOLE SYSTEMS ON NEUTRON STREAMING IN A MODERATOR. II. Takeda, Toshikazu; Sekiya, Tamotsu. Technol. Rep. Osaka Univ.; 22: 11-19(Feb 1972).

A new method of calculating the anisotropic second spatial moment of neutron distribution in an infinite moderator including regular array of holes in a square configuration is derived. In the calculation of the moment, the first flight of neutrons is taken into consideration exactly through the mean square free path, and the angular correlation of different paths is expressed by the product of the mean free paths at different energies and the anisotropic component of the scattering cross section. (auth)

3984 GENERAL THEORY OF SPHERICALLY SYMMETRIC BOUNDARY-VALUE PROBLEMS OF THE LINEAR TRANSPORT THEORY. Kanal, Madhoo (Univ. of Massachusetts, Amherst). J. Math. Phys. (N. Y.); 13: No. 7, 1013-25(Jul 1972).

A general theory of spherically symmetric boundary-value problems of the one-speed neutron transport theory is presented. The formulation is also applicable to the "gray" problems of radiative transfer. The Green's function for the purely absorbing medium is utilized in obtaining the normal mode expansion of the angular densities for both interior and exterior problems. As the integral equations for unknown coefficients are regular, a general class of reduction operators is introduced to reduce such regular integral equations to singular ones with a Cauchy-type kernel. Such operators then permit one to solve the singular integral equations by the standard techniques due to Muskhelishvili. Several spherically symmetric problems are discussed. However, the treatment is kept sufficiently general to deal with problems lacking azimuthal symmetry. In particular the procedure seems to work for regions whose boundary coincides with one of the coordinate surfaces for which the Helmholtz equation is separable. (auth)

3985 MULTIGROUP NEUTRON TRANSPORT. Belleni-Morante, A. (Univ., Bari, Italy); Busoni, G. J. Math. Phys. (N. Y.); 13: No. 8, 1146-50(Aug 1972).

The nature of the approximations involved in the multigroup treatment of the time-dependent neutron transport equation is studied by using the method of approximating sequences of Banach spaces. It is proved that solutions of the multigroup system converge, in a suitable sense, to the corresponding solutions of the exact transport equation. Moreover, the order of magnitude of the rate of convergence is indicated. (auth)

3986 STEADY-STATE SOLUTIONS IN THE TWO-GROUP THEORY OF NEUTRON DIFFUSION. Burniston, E. E. (North Carolina State Univ., Raleigh); Mullikin, T. W.; Siewert, C. E. J. Math. Phys.; 13: No. 10, 1461-5(Oct 1972).

Functional analysis arguments are used to prove the existence of a unique solution to the integral form of the two-group neutron-transport equation for subcritical half-spaces. The analytic properties of the solutions are discussed and used to prove that the partial indices of canonical solutions of the matrix Riemann problem, basic to H-matrix or half-range completeness considerations, are nonnegative. (auth)

3987 COHERENT NEUTRON SCATTERING AMPLITUDES OBTAINED FROM CHEMICAL COMPOUNDS. Koester, L.; Knopf, K. (Technische Univ., Munich). Z. Naturforsch.; 27a: No. 6, 901-5(Jun 1972). (In German).

The scattering amplitudes for powders were determined with good accuracy by utilizing the small-angle scattering of slow neutrons by Christiansen filters and comparing with well-known liquids. Investigations on powders of halides and sulfates yielded coherent scattering amplitudes of the bound atoms (in 10^{-13} cm): a(Na) = 3.63 ± 0.02; a(K) = 3.71 ± 0.02; a(Rb) = 7.08 ± 0.02; a(Cs) = 5.42 ± 0.02; a(Tl) = 8.89 ± 0.02; a(Br) = 6.77 ± 0.02; and a(I) = 5.28 ± 0.02. The scattering amplitudes of the liquids and the elements as standards are based on directly determined amplitudes from gravity-mirror measurements. (4 figures, 3 tables) (auth)

3988 GEOMETRY CORRECTIONS FOR DETERMINATION OF THE FERMI AGE OF SPHERICAL SHELL-SHAPED NEUTRON SOURCES. Gremm, O. (Technische Hochschule, Darmstadt, Ger.). Atomwirt., Atomtech.; 17: No. 11, 561-3(Nov 1972). (In German).

Described are studies about the Fermi age of spherical-shell-shaped sources which represent a part of a larger study on the Fermi age of delayed neutrons. To test the method, the known Fermi age of a Na–Be source was re-examined. The source had the shape of the surface of a sphere. Because of this deviation from an ideal point geometry, the obtained Fermi age was too large. The necessary geometry corrections were determined by Monte Carlo computations. Results showed that the usually applied corrections according to Mullin could not be used generally. (H.B.G.)

Nuclear Properties and Reactions, A ≤ 5

Refer also to abstracts 2550, 3627, 3847, 4013, 4029, 4034, and 4035.

3989 (FRNC-TH-246) STUDY OF THE OFF-ENERGY SHELL BEHAVIOR OF CERTAIN NUCLEON–NUCLEON POTENTIALS USING THE D(p,2p)n REACTION AT 156 MeV. Morlet, M. R. E. (Paris Univ., Orsay (France)). 1972. 117p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The D(p,2p)n reaction was studied in a coplanar kinematics at 156 MeV. The spectator neutron approximation (SMA) is valid. The simple model employed is derived from the Faddeev model. The agreement between theory and experiment is sufficiently good to enable the model to be used to describe the experimental results obtained in the region where the momentum transfer to the neutron is high. The experimental results obtained around the quasi-free p–p scattering peak are discussed, and an interpretation is given. The off-shell behavior of the Hamada–Johnston potential, the Tabakin potential, and the Sprung-de Tourreil potential are studied by comparing the results obtained with the experimental cross sections. (France)

3990 (FRNC-TH-273) ELASTIC SCATTERING AND CHARGE EXCHANGE REACTIONS OF 156-MeV PROTONS WITH MASS-3 NUCLEI. Narboni P. (Paris Univ., Orsay (France)). 1972. 87p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

An attempt was made to study and compare the effects of the nuclear structure and mechanisms intervening in $^3H(p,p)^3H$, $^3He(p,p)^3He$, and $^3He(p,n)^3He$ reactions at 156 MeV. The differential cross sections were measured in the center-of-mass system: between 15.8° and 178° for the (p,p) reactions and between 52.4° and 178° for (p,n) reactions. The multiple scattering process was analyzed up to the third order using the Glauber formalism. The simple scattering term was calculated using the impulse approximation. The Glauber theory appears to be highly efficient for forward scattering. Between 60° and 120° the theory provides an order of magnitude value for the cross sections. In backward scattering the Born approximation treatment and the treatment limited to the S state of the pickup reaction appear to be insufficient. The uncertainties in the theoretical calculations do not enable the difference between the ^3H and ^3He wavefunctions to be established. (France)

3991 (LA-DC-72-1122) POLARIZATION EXPERIMENTS AND FEW NUCLEON SYSTEMS. Ohlsen, Gerald G. (Los Alamos Scientific Lab., N. Mex.). 1972. 8p. (CONF-720819-15). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

The present experimental situation concerning polarization studies in few nucleon systems is surveyed. The current state of the art with respect to polarized beams is reviewed and some needed improvements are discussed. The major areas of interest for polarization experiments are briefly examined. (J.W.R.)

3992 (LNF-72/62) PRELIMINARY RESULTS OF THE $(\pi^+,^4He)$ INTERACTION AT 115 AND 150 MeV. Barbini, R.; Busso, L.; Costa, S.; Garfagnini, R.; Guaraldo, C.; Piragino, G.; Scrimaglio, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 5 Jul 1972. 6p. (CONF-720819-17). Dep. NTIS (U. S. Sales Only).

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

A diffusion cloud chamber (38-cm diameter), filled with He at 15 atm in a magnetic field of 5 kG, was used to measure the π^+ absorption cross section of ^4He in the 90 to 180 MeV pion energy

range. The results are compared with π^- data obtained by other authors. (L.T.W.)

3993 PHOTO SPALLATION OF ^{4}He INTO TWO DEUTERONS. Arkatov, Yu. M.; Vatset, P. I.; Voloshchuk, V. I.; (and others) (Physical-Technical Inst., Kazan). Yadern. Fiz.; 16: No. 1, 12-17(Jul 1972). (In Russian).

The results on investigating ^{4}He(γ,d)^{2}H reaction have been obtained with the help of a diffusion chamber. The experiment was performed with the γ beam at the electron linac at $E_{\gamma\,max} = 150$ MeV. The total cross sections and angular distributions have been obtained. The results are compared with the experimental data of other authors. Comparison with theoretical predictions, which take into account deuteron interaction in the final state is reported. The angular distribution indicates the domination of E2-absorption in this reaction. (auth)

3994 APPLICATION OF THE BURNETT–KROLL SOFT-PROTON THEOREM TO NUCLEON–NUCLEON BREMSSTRAHLUNG. Fearing, Harold W. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C.; 6: No. 4, 1136-42(Oct 1972).

An explicit analytic formula is given for the leading terms in the square of the matrix element for nucleon–nucleon bremsstrahlung in the relativistic, model-independent, soft-photon theory of Nyman. Such a formula should simplify direct and detailed comparisons of this soft-photon theory with experiment and with the predictions of other models. These comparisons have been difficult because Nyman in his original calculation of $NN \rightarrow NN\gamma$ was forced by the extremely complicated matrix element to use entirely numerical procedures. To obtain an analytic result the Burnett–Kroll theorem is used; it is thus possible to bypass many of the complications of a straightforward algebraic calculation. The general utility of the Burnett–Kroll theorem as a calculational tool for obtaining in an almost trivial fashion the leading terms in the squares of very complicated radiative matrix elements is emphasized. (3 figures) (auth)

3995 NEUTRON–DEUTERON AND NEUTRON–NEUTRON TOTAL CROSS SECTIONS IN THE RANGE 25 TO 60 MeV. Brady, F. P.; Knox, W. J.; Walraven, R. L.; Romero, J. L. (Univ. of California, Davis). Phys. Rev., C.; 6: No. 4, 1150-3(Oct 1972).

Measurements of the n–d total cross section to a precision of 1% are reported for the energy range 25 to 60 MeV. Nearly monoenergetic neutron beams were used whose energy was determined to about ±100 keV. The experimental values of σ_{nd} for energies ≥36 MeV are several percent larger than previous measurements in this range. By assuming charge symmetry, σ_{nn} can be calculated from the T = 1 phase shifts. The differences between experimental values of ($\sigma_{nd} - \sigma_{np}$) and σ_{nn} calculations are small and fairly well accounted for by correction terms based on the method of Glauber. (1 figure, 1 table) (auth)

3996 ISOSPIN IMPURITY OF THE 4.57-MeV STATE IN ^{6}Li. DeVries, R. M. (Univ. of California, Los Angeles); Slaus, Ivo; Sunier, Jules W.; Tombrello, T. A.; Nero, A. V. Phys. Rev., C.; 6: No. 4, 1447-8(Oct 1972).

The T = 1 isospin mixing in the 4.57-MeV (T = 0) state in ^{6}Li is investigated via the $\alpha + d \rightarrow {}^6Li^* \rightarrow \alpha + d^*$ reaction and found to be less than 1%. (2 tables) (auth)

3997 PERTURBATIVE CALCULATION OF SPIN OBSERVABLES IN NUCLEON–DEUTERON ELASTIC SCATTERING. II. INCLUSION OF A TENSOR FORCE. Pieper, S. C. (Case Western Reserve Univ., Cleveland). Phys. Rev., C.; 6: No. 4, 1157-62(Oct 1972).

A previous perturbative calculation of elastic nucleon–deuteron scattering using nucleon–nucleon S-, P-, and D-wave forces is extended to include the rank-1 $^3S_1 - {}^3D_1$ tensor force of Yamaguchi and Yamaguchi. Both the tensor and the P-wave forces are found to be important to the rank-2 polarizations of the deuteron. These forces yield excellent agreement with the data for these polarizations at 5.75 and 10.85 MeV. A comparison of calculations with just the tensor force to the exact calculations of Aarons and Sloan demonstrates the reliability of the perturbation technique. (8 figures, 1 table) (auth)

3998 COMPARISON OF THE CROSS SECTIONS FOR THE REACTIONS ^{2}H(p,2p)n AND ^{2}H(p,pn)p. Takeutchi, F. (Kernforschungszentrum, Karlsruhe, Ger.); Sakamoto, Y. Phys. Lett.; 41B: No. 4, 458-60(16 Oct 1972).

The correlation spectra of the cross sections for the reactions ^{2}H(p,2p)n and ^{2}H(p,pn)p are calculated with final-state interactions included. The results are compared with available data at incident energies of 46, 23, and 12.5 MeV. A large part of the difference between the spectra for these reactions is explained by taking into account the Coulomb force between the two protons. (auth)

3999 FORM FACTOR OF ^{4}He IN THE LOCAL DENSITY APPROXIMATION. Campi, X. (Institut de Physique Nucleaire, Orsay, France); Martorell, J.; Sprung, D. W. L. Phys. Lett.; 41B: No. 4, 443-5(16 Oct 1972).

The form factor for elastic electron–^{4}He scattering was computed using the density- and energy-dependent effective interaction G-0. This force, which was previously found to give a good account of gross properties of heavier nuclei, also gives a satisfactory representation of these data. (auth)

4000 LIFETIME EFFECTS IN (p,2p) REACTIONS. Pittel, S.; Austern, N. (Univ. of Pittsburgh). Phys. Rev. Lett.; 29: No. 20, 1403-6(13 Nov 1972).

Deep-hole excitations formed in knockout reactions decay rapidly by the ejection of additional nucleons. Other coherent processes that lead to the same final states are discussed. These may be important in some circumstances. (auth)

4001 ISOSPIN MIXING IN THE ELECTRIC-DIPOLE ^{4}He (γ,n) AND ^{4}He(γ,p) REACTIONS. Gibson, B. F. (Brooklyn Coll., N. Y.). Nucl. Phys.; A195: No. 2, 449-64(1972).

Possible isospin mixing of the $J^\pi = 1^-$ excited states of ^{4}He leading to sizable differences in the ^{4}He(γ,n)^{3}He and ^{4}He(γ,p)^{3}H cross sections in the giant resonance region is examined in a bound-state approximation. Results indicate that the general features of certain experimental data can be accounted for by the presence of Coulomb mixing of the (S = 1, T = 0) and (S = 1, T = 1) states in addition to the usual spin-orbit mixing of the (S = 0, T = 1) and (S = 1, T = 1) states. (3 figures, 2 tables) (auth)

4002 TEST OF THE TREIMAN–YANG CRITERION IN THE ^{2}H(d,pd)n REACTION AT 20 MeV BOMBARDING ENERGY. von Witsch, W.; Viefers, W.; Mommsen, H.; David, P.; Hinterberger, F. (Univ., Bonn). Nucl. Phys.; A195: No. 2, 617-22(1972).

The ^{2}H(d,pd)n reaction was investigated in a kinematically complete experiment at 20 MeV bombarding energy under conditions favorable for the observation of quasi-free neutron–deuteron scattering. Proton–deuteron coincidence spectra were obtained for five different values of the Treiman–Yang angle, ϵ. The results indicate that one pole graph is not sufficient to describe the reaction. (auth)

4003 EFFECT OF A VELOCITY-DEPENDENT POTENTIAL ON THE PHOTODISINTEGRATION OF ^{4}He. Islam, S.; Rafiqullah, A. K.; Hoq, F. Nargis (Dacca Univ., Bangladesh). Nucl. Phys.; A195: No. 2, 636-40(1972).

The cross section for the photodisintegration of ^{4}He into the (3 + 1) partition corresponding to the electric dipole transition was calculated by using first-order perturbation theory and neglecting the final-state interaction. The ground states of ^{4}He and ^{3}H are described by superposed Gaussian functions, the various parameters of which were determined from a variational calculation of the binding energies of these systems, using a central velocity-dependent potential. Results are compared with recent experiments and with other similar calculations. It appears that Gaussian functions are somewhat better than other functions from a variational point of view. Although the function is good in describing the ground-state properties, the maximum cross section does not appear at the correct energy. (1 figure, 2 tables) (auth)

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Refer also to abstracts 3633, 3830, 3996, 4038, 4053, 4061, 4074, 4117, 4184, and 4191.

4004 (FRNC-TH-274) STUDY OF THE ^{6}Li(α,2α) AND ^{6}Li(α,d$_0$) REACTIONS. INTERPRETATION IN THE DIAGRAM FORMALISM. Chan, T. U. (Grenoble Univ. (France)). 1972. 89p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Studies of the ^{6}Li(α,d$_0$) reaction between 28 and 40 MeV demonstrated the existence of a sharp increase in the angular distribution for backward scattering. The form of the angular distribution can not be interpreted in terms of knock-on theory. As the angular distributions corresponding to free (α,α) scattering present changes in form at energies of about 40 MeV, an attempt was made to relate the two phenomena. In view of this, ^{6}Li(α,2α) reactions were studied in the region of the quasi-elastic peak where the PWIA predicts a simple relation between the differential cross-section observed and the free (α,α) scattering cross section. The ^{6}Li(α,d$_0$) angular distribution was completed for higher energies, precise measurements being made in the 40-MeV region. The Faddeev diagram formalisms were used to interpret these two reactions. The P.W.I.A. is not sufficient to explain the results ob-

served. Good agreement is obtained between theory and experiment when an α + d model is used for ^{6}Li and it is assumed that $\alpha\alpha$ and α interactions determine the cross sections for the ^{6}Li-(α,2α) and ^{6}Li(α,d_0) reactions. (France)

4005 INVESTIGATION OF THE REACTION (n,α) ON LIGHT NUCLEI OF PHOTOEMULSION UNDER THE INFLUENCE OF 4.9 MeV NEUTRONS. Kirichenko, M. V.; Solov'eva, Z. I. Yadern. Fiz.; 16: No. 1, 17-20(Jul 1972). (In Russian).

Angular distributions in C.M.S. for α-particles have been obtained in the reactions (n,α) on nitrogen and oxygen nuclei at the neutron energy of 4.9 ± 0.2 MeV with the help of the nuclear emulsion method. The results are discussed. (auth)

4006 AN INVESTIGATION OF THE ^{9}Be(d,n)^{10}B NUCLEAR REACTION. Srivastava, M. L.; Sah, J. P. (Lucknow Univ., India). Indian J. Pure Appl. Phys.; 10: No. 3, 200-1(Mar 1972).

The outgoing neutrons from a ^{9}Be target (96 keV thick) bombarded by 650 keV deuterons have been recorded on Ilford K2 nuclear emulsion plates placed at 0°, 45°, 60°, 90°, 120°, 135° and 150° with respect to the deuteron beam and 7000 recoil proton tracks have been recorded. The Q-value spectrum indicates the existence of levels of ^{10}B at 0.72, 1.75, 2.20, 2.86 and 3.69 MeV besides the ground state. Confirmatory evidence has been found for the existence of the 2.86 MeV level whose existence has been under dispute in earlier studies. The angular distribution of the neutrons shows that the formation of ^{10}B in the 3.69 MeV state is by the stripping process and is well explained by Butler's theory. (auth)

4007 INVESTIGATION OF THE REACTION (e,e'p) ON ^{6}Li. Antuf'ev, Yu. N.; Agranovich, V. L.; Kuz'menko, V. S.; Miroshnichenko, I. I.; Sorokin, P. V. (Physical-Technical Inst., Kiev). JETP Lett. (USSR) (Engl. Transl.); 16: No. 2, 52-3(20 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 2, 77-9(20 Jul 1972).

The ^{6}Li(e,e'p) reaction was studied at an incident energy of 1180 MeV and with resolution sufficient to separate the s- and p-shell effects. The secondary electrons and protons were detected in coincidence and were momentum-analyzed using magnetic spectrometers. The cross section of the reaction was determined as a function of the missing energy. The s- and p-shell proton distribution parameters were deduced. (J.W.R.)

4008 SPECTROSCOPIC FACTORS FOR THE REACTIONS ^{10}B(d,n)^{11}C AND ^{22}Ne(d,n)^{23}Na. Childs, Wendell Arthur. Charlottesville, Va.; Univ. of Virginia (1972). 282p. University Microfilms Order No. 72-22,654.

Thesis.

Using time-of-flight techniques the absolute differential cross sections for 12 levels populated in the reaction ^{10}B(d,n)^{11}C and 32 levels in the reaction ^{22}Ne(d,n)^{23}Na were measured with a flight path of seven meters. Angular distributions from 0 to 160 degrees were measured at a deuteron bombarding energy of 5.5 MeV. In addition, neutron yields were measured at deuteron bombarding energies of 2.5 to 5.5 MeV in 500 keV steps. Spectroscopic factors and statistical compound nucleus contributions are extracted by treating the observed cross sections as an incoherent sum of direct interaction and compound nucleus contributions. Analysis was performed with the DWBA code DWUCK and the Hauser–Feshbach code MANDY. The ^{11}C spectroscopic analysis is compared with shell model calculations of the fractional strengths for major components of the single nucleon transfers in the p-shell. More spreading of the p-wave strength is found than Cohen and Kurath's theoretical calculations indicate. The ^{23}Na spectroscopic results are compared with the predictions of the Nilsson model for single nucleon transfer in deformed nuclei. The unbroken deformed core assumption is found to be generally valid for the proton stripping process to this nucleus. (Diss. Abstr. Int., B)

4009 ^{12}C(p,pn)^{11}C CROSS SECTION AT 7.6 GeV. Butler, G. W.; Kaufman, S. B.; Steinberg, E. P.; Wilkins, B. D. (Argonne National Lab., Ill.). Phys. Rev., C.; 6: No. 4, 1153-6(Oct 1972).

The absolute cross section for the ^{12}C(p,pn)^{11}C reaction was measured in an external beam of the Argonne zero gradient synchrotron at 8.5 GeV/c momentum (7.6-GeV protons). Proton fluxes were measured with a scintillation counter telescope, and the 20.4-min ^{11}C activity induced in $\frac{1}{8}$-in.-thick plastic scintillators was determined both by internal scintillation counting and by β^+-annihilation radiation counting with a NaI(Tl) well crystal. A correction for the formation of ^{11}C by secondary particles was determined, and a correction was made for the small π^+ contamination of the proton beam. The ^{12}C(p,pn)^{11}C cross section at 7.6 GeV is 28.2 ± 0.6 mb. (auth)

4010 DIRECT INTERACTIONS AND THE ^{6}Li + ^{6}Li → α + α + α REACTION. Gadeken, L. L.; Norbeck, E. (Univ. of Iowa, Iowa City). Phys. Rev., C.; 6: No. 4, 1172-80(Oct 1972).

The interaction of ^{6}Li with ^{6}Li was found to yield three ^{4}He nuclei via a direct process, as well as through intermediate ^{8}Be states. Large peaks attributed to direct interactions were observed in the experimental data at bombarding energies of 2.0, 6.0, and 13.0 MeV. These peaks were fitted using a simple model which assumed an α + d cluster structure for the ^{6}Li nuclei and an interaction potential which acted only between the deuterons. (7 figures) (auth)

4011 SPIN-FLIP PROBABILITY IN THE INELASTIC SCATTERING OF 7.48-MeV NEUTRONS FROM THE 4.43-MeV STATE OF ^{12}C. McDaniel, F. D.; McDonald, M. W.; Steuer, M. F.; Wood, R. M. (Univ. of Georgia, Athens). Phys. Rev., C.; 6: No. 4, 1181-91(Oct 1972).

An (n,n'γ) coincidence method was used to determine the neutron spin-flip probability in inelastic scattering. The experimental method consists of neutron time-of-flight and neutron–γ coincidence techniques with the de-excitation γ ray detected perpendicular to the neutron scattering plane. The angular distribution of the spin-flip probability for the first $J^\pi = 2^+$ excitation in carbon was determined at an energy of 7.48 MeV. The neutron spin-flip results were found to be similar to the proton spin-flip results in this energy region. The experimental results were compared to the predictions of an antisymmetrized distorted-wave calculation, which did not provide good fits to the spin-flip data. The spin-flip predictions were sensitive to the optical-model parameters and were dominated by spin–orbit distortion in the elastic channels. The mechanism of core polarization dominated the inelastic amplitudes, masking the effects of the effective interaction on the extracore nucleons. (auth)

4012 COMMENT ON ^{12}C(^{12}C,α)^{20}Ne EXCITATION FUNCTIONS. Courtney, W. J.; Fortune, H. T. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C.; 6: No. 4, 1453-4 (Oct 1972).

The excitation function for the ^{12}C(^{12}C,α)^{20}Ne reaction leading to the 2^+ state at 7.83 MeV possesses oscillations similar in width to those observed for the low-lying states. For the 7.83-MeV state, the oscillations are considerably damped in magnitude, and are superimposed on a large underlying cross section that varies much more slowly with energy. (auth)

4013 OBSERVATION OF HIGH-LYING LEVELS IN ^{8}Be FROM α–α ELASTIC SCATTERING. Bacher, A. D.; Resmini, F. G.; Conzett, H. E.; (and others) (Univ. of California, Berkeley). Phys. Rev. Lett.; 29: No. 19, 1331-3(6 Nov 1972).

The elastic scattering of α particles by ^{4}He was measured in the energy range between 30 and 70 MeV. A phase-shift analysis was used to investigate the even-spin, positive-parity levels in ^{8}Be in the region between 15 and 35 MeV of excitation. New 0^+ and 4^+ levels were located near 20.3 and 25.6 MeV, respectively. The positions of five 2^+ levels and an additional 4^+ level are compared with previous work and with theoretical predictions based on the intermediate-coupling shell model. (2 figures) (auth)

4014 STRUCTURE IN THE EXCITATION FUNCTIONS OF ^{12}C(^{16}O,p)^{27}Al, ^{12}C(^{16}O,d)^{26}Al, AND ^{12}C(^{16}O,α)^{24}Mg. Cosman, E. R. (Massachusetts Inst. of Tech., Cambridge); Sperduto, A.; Cormier, T. M.; (and others). Phys. Rev. Lett.; 29: No. 19, 1341-4(6 Nov 1972).

The excitation functions for the above reactions show evidence for a large statistical compound-nucleus contribution. In addition, a broad structure (~1 to 2 MeV) is seen in ^{12}C(^{16}O,α)^{24}Mg, and narrower correlated resonances (~300 keV) appear in ^{12}C(^{16}O,p)^{27}Al—one of them, at $E_{c.m.}$ = 19.71 MeV, having the same position and width as a recently found anomaly in ^{16}O + ^{12}C elastic and inelastic scattering. (auth)

4015 DIFFERENTIAL CROSS SECTIONS OF (n,p) AND (n,α) REACTIONS FOR ^{19}F, ^{29}Si, ^{32}S, AND ^{40}Ca AT 5.85 MeV. Foroughi, F.; Rossel, J. (Univ., Neuchatel, Switzerland). Helv. Phys. Acta; 45: No. 3, 440-50(31 Aug 1972). (In French).

Using $\Delta E \cdot E$ discrimination in a counter telescope, $\sigma(\theta)$ and σ_t have been measured for (n,α) and (n,p) reactions in open shell nuclei (^{19}F, ^{29}Si, ^{32}S) and in double magic ^{40}Ca. Results are given concerning ^{19}F(n,α_0 + α_1 + α_2 + α_3); ^{29}Si(n,α_0) and (n,α_1); ^{32}S(n,α_0), (n,p_0 + p_1) and (n,p_2); ^{40}Ca(n,α_0), (n,α_1 + α_2) and (n,p_0 + p_1). In the open shell nuclei σ(n,α) angular distributions are mostly forward compared to (n,p) processes but no other specific shell effect is observed. In ^{40}Ca the situation is reversed; $\sigma(\theta)$ has no remarkable structure for (n,α) whereas for (n,p) it is strongly peaked forward. Previous conclusions on α particle dominance in compound ^{41}Ca decay are confirmed. As a by-product of preliminary measurements we give upper bounds for (n,α) and (n,p) cross sections in ^{53}Cr and ^{47}Ti. (auth)

4016 MECHANISM OF THE ^{12}C(^{6}Li,d)^{16}O REACTION LEADING TO THE 6.92- AND 7.12-MeV LEVELS OF ^{16}O. Zaidins,

Clyde S. (Univ. of Colorado, Boulder). Phys. Rev., C.; 6: No. 4, 1444(Oct 1972).

The contributions of compound-nucleus and direct processes to the $^{12}C(^{6}Li,d)^{16}O$ 6.92- and 7.12-MeV levels at two c.m. energies are discussed. (auth)

4017 K-ELECTRON-CAPTURE-TO-POSITRON-EMISSION RATIO IN THE DECAYS OF ^{15}O AND ^{19}Ne. Leiper, W.; Drever, R. W. P. (Univ. of Glasgow). Phys. Rev., C.; 6: No. 4, 1132-6(Oct 1972).

The K/β^+ ratio in the decays of ^{19}Ne and ^{15}O were measured as $(9.6 \pm 0.3) \times 10^{-4}$ and $(10.7 \pm 0.6) \times 10^{-4}$, respectively. A gas-flow proportional counter, operating in anticoincidence with the surrounding plastic scintillator, was used. Theoretical K/β^+ ratios for ^{19}Ne and ^{15}O were computed by using exchange-overlap corrections calculated by Vatai and, separately, exchange corrections extrapolated from the results of Bahcall for $14 \leq Z \leq 37$. The experimental results were found to be in better agreement with Vatai's calculations. (6 figures, 1 table) (auth)

4018 MIRROR β DECAYS OF ^{12}B AND ^{12}N TO $^{12}C_{4.44}$. Alburger, David E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C.; 6: No. 4, 1167-71(Oct 1972).

The β decays of ^{12}B and ^{12}N to the 4.44-MeV first excited state of ^{12}C were studied by means of $\beta-\gamma$ coincidence measurements using a 4π plastic scintillator and a NaI(Tl) detector. The ratio of $^{12}N/^{12}B$ β-ray branches to the 4.44-MeV state is found to be 1.52 ± 0.06; this leads to $ft^+/ft^- = 1.06 \pm 0.04$ for this branch. This result removes the only severe exception to the systematic trend of positive $\delta = (ft^+/ft^-) - 1$ for mirror decays, and is in agreement with a recent calculation of the binding-energy effect. In separate measurements the absolute β-ray branch of ^{12}B to the ^{12}C 4.44-MeV state is found to be $(1.27 \pm 0.06)\%$. (3 figures) (auth)

4019 NUCLEON EXCHANGE IN SCATTERING OF CARBON ISOTOPES. Bohlen, H. G.; Feil, M.; Gamp, A.; (and others) (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett.; 41B: No. 4, 425-8(16 Oct 1972).

The elastic scattering of ^{12}C by ^{13}C and ^{14}C and of ^{13}C by ^{14}C was measured in the vicinity of the Coulomb barrier. The structure of the angular distributions is described by consistently using the method of molecular wave functions which takes into account the exchange of the valence particles. (auth)

4020 ^{3}He INDUCED REACTION ON ^{7}Li AT BOMBARDING ENERGIES OF 2.2 TO 3.2 MeV. Liu, Y. C. (National Tsing Hua Univ., Hsinchu, Taiwan). Chin. J. Phys. (Taiwan); 10: No. 2, 76-83(Oct 1972).

Angular distributions for the reactions $^{7}Li(^{3}He,p)^{9}Be$ (ground state, 1.75, 2.43 and 3.03 MeV levels) and $^{7}Li(^{3}He,d)^{8}Be$ (ground state and 2.7 MeV level) have been measured for bombarding energies between 2.2 and 3.2 MeV. An analysis of the data has been made using the Hauser–Feshbach theory and DWBA and Newns' PWBA calculation. (auth)

4021 $^{19}F(p,2p)^{18}O$ REACTION. High, M. D. (Indiana Univ., Bloomington); Bedi, J. F.; Devins, D. W.; Shapiro, P.; Deutchman, P. A. Phys. Lett.; 41B: No. 5, 588-90(30 Oct 1972).

Symmetric coplanar angular correlations for the reaction $^{19}F(p,2p)^{18}O$ at $E_p = 42.7$ MeV were measured at angles between 12° and 117°. The results compare favorably with a distorted-wave t-matrix calculation using realistic optical model parameters if an rms radius of about 4.0 fm for the 2s state in ^{19}F is used. (auth)

4022 ACTIVATION CROSS SECTIONS OF THE $^{16}O(n,p)^{16}N$ AND $^{18}O(n,\alpha)^{15}C$ REACTIONS FOR 14-MeV NEUTRONS. Schmidt-Hoenow, M.; Herr, W. (Univ., Cologne). Radiochim. Acta; 17: No. 3, 142–6(Oct 1972). (In German).

A redetermination of the activation cross section of the nuclear reaction $^{16}O(n,p)^{16}N$ ($T = 7.1$ s) for 14-MeV neutrons was done by means of a Ge(Li) detector measuring a σ value of 35.1 mb. The influence of the experimental conditions altering the neutron spectrum of a 150 kV generator was investigated and considered. Moreover, the still unknown cross section of the reaction $^{18}O(n,\alpha)^{15}C$ was determined relative to the $^{16}O(n,p)^{16}N$ reaction. The resulting σ value = 7.6 mb (average neutron energy $\overline{E_n} = 14.3$ MeV) was found to be smaller by a factor of 7 than predicted. (auth)

4023 S-WAVE NEUTRON RESONANCE. $1/2^+$ STATE OF ^{9}Be. Takeichi, Yoshinori; Une, Tsutomu; Nakamura, Kosuke; Kohmura, Toshitake; Miyazima, Tatuoki (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 48: No. 3, 858-67(Sep 1972).

It is shown that, although s-wave neutron resonance is ruled out in a conventional form of nuclear potential, the polarization of the deformed core nucleus can produce $1/2^+$ resonance. Using the coupled-channel method, we obtain this result concerning the $1/2^+$ state of ^{9}Be. The state may be one example of the resonances suggested by the optical potential theory of Feshbach. (auth)

4024 ELECTRON SCATTERING FORM FACTORS FOR ^{12}C IN THE HARTREE–FOCK APPROXIMATION. Lee, H. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Phys. Lett.; 41B: No. 4, 421-4(16 Oct 1972).

Elastic and inelastic electron scattering form factors for the ground (0_1^+) and first 2^+ and 4^+ states are calculated in the unrestricted, projected, Hartree–Fock approximation and compared with experimental data. A practical method, applicable to any type of wave function, is given for the calculation of the center-of-mass correction to the form factor. (auth)

4025 IMPORTANCE OF MOMENTUM DEPENDENT TERMS IN RADIATIVE PION CAPTURE. Vergados, J. D.; Baer, H. W. (Univ. of California, Berkeley). Phys. Lett.; 41B: No. 5, 560-4(30 Oct 1972).

The contribution of the momentum-dependent terms in radiative pion capture from bound atomic orbits is investigated. A shell-model calculation for ^{6}Li shows that the momentum-dependent terms represent ~2% of the 1s capture rate and up to 40% of 2p capture rates. (auth)

4026 CONVERGENCE OF THE EFFECTIVE SHELL-MODEL INTERACTION IN THE s–d SHELL. Baranger, E. U.; Vary, J. P. (Massachusetts Inst. of Tech., Cambridge). Contract AT(11-1)-3069. Phys. Lett.; 41B: No. 5, 568-70(30 Oct 1972).

The results of an exact shell-model calculation for ^{18}O by Lo Iudice, Rowe and Wong are compared with those obtained with a perturbation expansion for the effective shell-model interaction complete through third order. The comparison suggests a converging expansion. The importance of folded diagrams in third order is demonstrated. (auth)

4027 MICROSCOPIC DESCRIPTION OF SCATTERING OF LOW ENERGY NEUTRONS BY ^{12}C. I. COUPLED CHANNEL METHOD. Mori, Akihiko; Terasawa, Tokuo (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 48: No. 3, 826-39(Sep 1972).

The total cross section for the elastic scattering of neutrons by ^{12}C up to $E_n = 4.4$ MeV is calculated by the coupled channel method. A coupling form factor is constructed from a microscopic wave function of ^{12}C and a realistic two-body interaction between the incident neutron and a nucleon of the target. The renormalization of the interaction strength is found to be necessary, which is discussed in connection with antisymmetrization effects. To examine the validity of the model for other experimental data, the energies of the two positive parity bound states of ^{13}C and the phase shifts for elastic proton scattering up to $E_p = 7.8$ MeV are also calculated. (auth)

4028 RESONANCES IN THE EXCITATION FUNCTIONS OF THE ALPHA-PARTICLE AND PROTON EXIT CHANNELS OF THE $^{16}O + ^{12}C$ SYSTEM NEAR THE COULOMB BARRIER. Voit, H.; Hartmann, G.; Helb, H. D.; Ischenko, G.; Siller, F. (Univ., Erlangen, Ger.). Z. Phys.; 255: No. 5, 425-30(1972).

Correlated resonances were found in the excitation functions of the α-particle and proton exit channels of the $^{16}O + ^{12}C$ system at energies in the region of the Coulomb barrier. These resonances cannot be explained as statistical fluctuations. There are experimental indications that these resonances may be due to α-particle doorway states. (auth)

4029 PROXIMITY $^{3}He(n,p)^{3}H$ REACTION FOLLOWING THE SEQUENTIAL $^{6}Li(d,^{3}He)^{5}He(n)^{4}He$ REACTION AND THE LIFETIME OF ^{5}He. Kato, S.; Orihara, H.; Kubono, S.; (and others) (Tohoku Univ., Sendai). Nucl. Phys.; A195: No. 2, 534-44(1972).

Evidence for the proximity $^{3}He(n,p)^{3}H$ reaction in the final state of the sequential $^{6}Li(d,^{3}He)^{5}He(n)^{4}He$ process was observed. The behavior of the positions of the peaks in the two-dimensional spectra was consistent with kinematical predictions. It should be emphasized that the proximity scattering was extended to a rearrangement process. The strength of the process gave direct information on the lifetime of the ground state of ^{5}He. A classical estimate led to $\tau = 1.4 \times 10^{-21}$ s, which is the shortest nuclear lifetime directly measured. The consistency of this value with the level width gives quantitative support for the occurrence of the proximity reaction. (auth)

4030 $^{7}Li(p,pt)^{4}He$ REACTION. Jain, A. K.; Sarma, N. (Bhabha Atomic Research Centre, Bombay). Nucl. Phys.; A195: No. 2, 566-76(1972).

The reaction $^{7}Li(p,pt)^{4}He$ was analyzed in the distorted-wave impulse approximation by using a cluster model. All exchange terms arising from antisymmetrization of the target wave func-

tion were calculated. When the correct asymptotic form for the intercluster wave function is used, the magnitude and shape of the measured angular correlation are reproduced, both at 156 and 55 MeV. The analysis indicates that ^{7}Li in its ground state is strongly clustered. (7 figures, 1 table) (auth)

4031 EXCHANGE EFFECT IN THE 166 MeV α-PARTICLE ELASTIC SCATTERING ON ^{6}Li. Bachelier, D. (Institut de Physique Nucleaire, Orsay, France); Bernas, M.; Boyard, J. L.; (and others). Nucl. Phys.; A195: No. 2, 361-8(1972).

The angular distribution of the elastic scattering of 166-MeV α particles by ^{6}Li nuclei was measured from 3° to 175° (c.m.). The backward rise of the cross section is explained in terms of two-nucleon pickup. The symmetry of the entrance and exit channels makes the measurement a good test of the applicability of finite-range DWBA calculations for this exchange effect. This effect is shown to become negligible for heavier nuclei like ^{40}Ca. (5 figures, 2 tables) (auth)

4032 LOW-ENERGY CROSS SECTIONS FOR ^{10}B(p,α)^{7}Be. Szabo, J.; Csikai, J.; Varnagy, M. (Kossuth Univ., Debrecen, Hungary). Nucl. Phys.; A195: No. 2, 527-33(1972).

Cross sections were determined for the ^{10}B(p,α)^{7}Be reaction between 60 keV and 180 keV proton energies by using an activation method as well as direct α detection by a solid-state track detector. In the energy region investigated the influence of the 8.694-MeV state of ^{11}C on S(E) was observed. The cross section for the Gamow energy is given. The half-width of this level and the branching ratio ^{7}Be(ϵ)^{7}Li were found to be $\Gamma \approx 300$ keV and R = 0.104 ± 0.003, respectively. (5 figures, 1 table) (auth)

4033 EXPERIMENTAL STUDY OF THE ^{7}Li(d,α)^{5}He REACTION AT LOW ENERGIES. Decharge, J. (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France); Surget, G.; Bruno, G.; Decharge, M. Y. J. Phys. (Paris); 33: No. 5, 485-94(May 1972). (In French).

In the 0.45- to 2-MeV range, the ^{7}Li + d reaction, which leads to two α particles and a neutron in the exit channel, can be described as a sequential mechanism occurring with the formation of the ^{9}Be compound nucleus and the intermediate ^{5}He ground state nucleus. Other competing mechanisms involving the first excited state of ^{5}He and the 11.4-MeV state of ^{8}Be as well as the simultaneous emission of two ^{4}He particles and a neutron have a negligible effect on the yield of the reaction. Analysis made in the R matrix formalism of the angular distributions of the α_1 from the first stage, the angular correlations between the α_1 and α_2 emitted by ^{5}He in the ground state and the ^{7}Li(d,d)^{7}Li elastic scattering leads to the attribution of the following spin and parity values for the 17.28- and 17.48-MeV levels of ^{9}Be: $^{3}/_{2}^{-}$ and ($^{3}/_{2}$, $^{5}/_{2}$)$^{+}$. (France)

4034 STUDY OF THE SPECTRA OF FAST DEUTERONS PRODUCED IN THE INTERACTION OF 670 MeV PROTONS WITH NUCLEI. Azhgirei, L. S. (Joint Inst. for Nuclear Research, Dubna, USSR); Cisek, Z.; Krumstein, Z. V.; (and others). Nucl. Phys.; A195: No. 2, 581-95(1972).

The spectra of deuterons emitted at angles of 6.5°, 9.5°, 13.5°, and 16° (lab system) in the interaction of protons with the nuclei ^{1}H, ^{2}H, ^{6}Li, ^{7}Li, C, Al, Cu, Rh, and Pb were measured in the momentum range 700 to 1700 MeV/c. The secondary particles were analyzed with the help of magnetic and time-of-flight spectrometers. The differential cross sections for deuteron production in the reactions p + $\langle$2N$\rangle$ → N + d and p + $\langle$N$\rangle$ → d + π were measured for selected nuclei and angles. The effective numbers of nucleons and of two-nucleon clusters for the investigated nuclei were determined. The results obtained are discussed in terms of the dispersion theory of direct nuclear reactions. (10 figures, 5 tables) (auth)

4035 ^{6}Li(p,2p)^{5}He REACTION AT 100 MeV. Mackenzie, I. A. (McGill Univ., Montreal); Mark, S. K.; Li, Tseh Y. Nucl. Phys.; A195: No. 2, 609-16(1972).

The angular correlation measurement of the ^{6}Li(p,2p)^{5}He reaction at 100 MeV was performed in a symmetric and coplanar geometry covering an angular range from 30° to 54°. Two conventional $\Delta E - E$ telescope systems were used to detect the two outgoing protons. Excitations to the three lowest states of ^{5}He were observed. Experimental form factors for the ground state and the 16.7-MeV state were evaluated, and the characteristic momentum-distribution parameters were extracted. A value of 1.40 ± 0.12 was obtained for the peak-to-valley ratio of the ground-state form factor; deviations from the simple shell-model description for the ground state of ^{6}Li were indicated. The cross-section ratio of the 16.7-MeV state to the ground state was observed to vary with incident energy. This might reflect the increasing significance of distortion and absorption effects at lower incident energies. (3 figures, 1 table) (auth)

Nuclear Properties and Reactions, 20 ≤ A ≤ 38

Refer also to abstracts 3633, 3856, 4008, 4015, 4034, 4056, 4073, 4193, and 4195.

4036 (CONF-721109-4) TESTING OF PHOTON PRODUCTION DATA FROM ENDF/B-III MATERIAL 1135 (^{27}Al). Ford III, W. E. (Oak Ridge National Lab., Tenn.). [nd]. 7p. Dep. NTIS.

From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

Photon production data for ^{27}Al were tested by comparing (n_{th},γ) yields with published data and by comparing measured and calculated secondary γ pulse-height spectra. (L.T.W.)

4037 ANGULAR DISTRIBUTION OF LOW ENERGY NEUTRONS FROM NUCLEAR μ^- CAPTURE IN SULPHUR AND CALCIUM. Voitkovska, I.; Evseev, V. S.; Kozlovski, T.; Nikolina, A. A.; Roganov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 15: No. 5, 939-44(May 1972). (In Russian).

The dependence of the asymmetry coefficient B in the angular distribution of neutrons from nuclear μ^--capture in S and Ca on the recoil proton energy has been measured. The measurements were carried out in the region from 2.5 to 10 MeV (S) and from 2 to 17 MeV (Ca) by the method of meson spin precession in a magnetic field. The B values are close to zero. It does not contradict the modern models of the nuclear μ^--capture. (auth)

4038 VARIATION OF THE ^{32}S COMPOUND-NUCLEUS WIDTH WITH ENERGY AND SPIN. Leachman, R. B.; Fessenden, P.; Gibbs, W. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C.; 6: No. 4, 1240-54(Oct 1972).

Coherence widths of the compound nucleus ^{32}S were determined from excitation functions of the differential cross section for the reactions ^{31}P(p,α)^{28}Si and ^{16}O(^{16}O,α)^{28}Si. The proton-induced reaction provided a lower average spin of the compound nucleus. Excitation functions were measured for ^{31}P(p,α)^{28}Si from 13.90- to 14.24- and from 26.62- to 30.56-MeV compound-nucleus energy. The average coherence widths were 11 ± 1.2 and 95 ± 15 keV, respectively. For the oxygen-induced reaction, excitation functions were measured from 28.99 to 34.42 MeV with a resulting 73 ± 7-keV coherence width, which is nearly the same as for the lower-spin proton-induced case. These coherence widths were used to test the Gilbert and Cameron level-density formulation. Good agreement with the above data was obtained if the compound nucleus ^{32}S is considered to be spherical in this formulation. The increase in the calculated width for the ^{16}O-induced reaction with increasing excitation energy is greater than indicated by combining these data with another measurement at higher excitation. (14 figures, 2 tables) (auth)

4039 LIFETIME MEASUREMENTS IN ^{35}Cl AND ^{37}Cl. Brock, J. E. (Univ. of Auckland, N. Z.); Luketina, I. A.; Poletti, A. R. Phys. Rev., C.; 6: No. 4, 1298-1304(Oct 1972).

Lifetimes of low-lying excited states in the nuclei ^{35}Cl and ^{37}Cl were measured by the Doppler-shift attenuation method. Energies (in keV) and lifetimes (in ps) were determined as follows: ^{35}Cl: 1219.4 ± 0.1 ($0.21^{+0.06}_{-0.04}$), 1763.2 ± 0.1 ($0.49^{+0.09}_{-0.07}$), 2645.7 ± 0.2 (0.26 ± 0.06), 2693.5 ± 0.1 (<0.12), 3002.5 ± 0.5 (<0.08), 3162.60 ± 0.10 (>10); ^{37}Cl: 1726.6 ± 0.1 ($0.17^{+0.05}_{-0.04}$), 3087.0 ± 1.0 (<0.09), 3103.0 ± 0.2 (>10). (4 figures, 6 tables) (auth)

4040 MIXING OF SU(3) SYMMETRY FOR NUCLEI IN THE ds-SHELL. Parikh, J. C. (Physical Research Lab., Ahmedabad, India). Phys. Lett.; 41B: No. 4, 468-72(16 Oct 1972).

Spectral distribution methods of French are applied to evaluate intensities near the ground state of different SU(3) representations for the ds-shell nuclei. For nuclei with 20 ≤ A ≤ 24 there is a dominant symmetry, but for the heavier ones large admixtures are present. (auth)

4041 HARTREE–FOCK CALCULATIONS OF BUBBLE NUCLEI. Davies, K. T. R. (Oak Ridge National Lab., Tenn.); Wong, C. Y.; Krieger, S. J. Phys. Lett.; 41B: No. 4, 455-7(16 Oct 1972).

Hartree–Fock calculations of ^{36}Ar and of ^{200}Hg in spherical configurations exhibit densities which are very much depleted in the interior region. The depletion agrees well with previous theoretical predictions of bubble nuclei. (auth)

4042 EXCITED-STATE-THRESHOLD RESONANCE EFFECTS IN ^{9}Be(p,p$_0$)^{9}Be AND ^{9}Be(p,n)^{9}B. Votava, H. J.; Thompson, W. J. (Univ. of North Carolina, Chapel Hill). Phys. Lett.; 41B: No. 4, 405-7(16 Oct 1972).

The first evidence for the importance of excited-state-threshold effects in resonance reactions is reported in a description of

anomalous resonance effects in $^{9}Be(p,p_0)^{9}Be$ as caused by the proximity of the $^{9}Be(p,n_4)^{9}B^*$ threshold energy to the resonance energy. Experimental tests of the description presented are suggested. (auth)

4043 INVESTIGATION OF THE $^{27}Al(p,\gamma)^{28}Si$ REACTION IN THE PROTON ENERGY RANGE 925 TO 2,760 keV. Hsu, T. H.; Lin, E. K.; Hsu, C. C.; (and others). (National Tsing Hua Univ., Hsinchu, Taiwan). Chin. J. Phys. (Taiwan); 10: No. 2, 55-68(Oct 1972).

The $^{27}Al(p,\gamma)^{28}Si$ reaction has been studied in the proton energy range 925 to 2,760 keV. Seventy-four resonances were observed. Gamma-ray spectra of two new strong resonances at 2,720 and 2,748 keV, corresponding to the 14.210 and 14.237 MeV levels in ^{28}Si, were measured by a 50-cc Ge(Li) detector. Decay schemes for these two resonance levels were proposed and branching ratios of the de-excitation of gamma-rays were determined. From arguments on transition probabilities it seems to favor a spin assignment for both resonance levels to be $J^{\pi} = 3^+$. (auth)

4044 $^{20}Ne(n,\alpha)^{17}O$ REACTION INDUCED BY 14.1 MeV NEUTRONS. Lin, S. Y.; Hsu, Y. C.; Chou, M. C.; (and others) (National Taiwan Univ., Taipei). Chin. J. Phys. (Taiwan); 10: No. 2, 69-75(Oct 1972).

Alpha particles produced by the interaction of 14.1-MeV neutrons with neon have been studied by using a cloud chamber. The energy distribution of the alpha particle is agreeable with the predictions of the evaporation theory. The relative level density plotted from the energy distribution of the alpha particles fits a straight line, except on the high excitation energy side and corresponds to a nuclear temperature of 1.78 ± 0.05 MeV. The angular distribution in the center-of-mass system is approximately symmetrical with respect to 90°. The spin cut-off parameter is estimated to be about 1.66 ± 0.05 from the angular distribution. The total (n,α) cross section for the reaction is found to be 274 ± 4 mb. (auth)

4045 STUDIES OF THE $^{27}Al(^{3}He,^{3}He)^{27}Al$ AND $^{27}Al(^{3}He,\alpha)^{26}Al$ REACTIONS. Lin, C. S. (National Tsing Hua Univ., Hsinchu, Taiwan); Lin, E. K.; Song, P. S.; (and others). Chin. J. Phys. (Taiwan); 10: No. 2, 84-92(Oct 1972).

Angular distributions for the elastic scattering of 5.0, 5.5, 6.0 and 6.5 MeV ^{3}He particles by ^{27}Al nuclei have been measured for scattering angles between 35° and 160° in the laboratory system. The data have been analyzed using optical model Woods–Saxon potentials. The reaction $^{27}Al(^{3}He,\alpha)^{26}Al$ has been measured at incident energy of 6.5 MeV. Angular distributions were measured for the ground, first (0.229 MeV), second (0.418 MeV), third (1.059 MeV), fourth (1.760/1.852 MeV) and sixth (2.07/2.08 MeV) excited states in ^{26}Al. The spectra were recorded at every 10° between 50° and 160° (lab). (auth)

4046 EFFECT OF PARTICLE NUMBER FLUCTUATION ON THE ROTATIONAL STATES OF PAIRED LIGHT NUCLEI. Goeke, K.; Garcia, J.; Faessler, A. (Kernforschungsanlage, Juelich, Ger.). Phys. Lett.; 41B: No. 5, 557-9(30 Oct 1972).

Hartree–Bogolyubov calculations with simultaneous projection on sharp particle number and good angular momentum after the variation are performed for ^{22}Ne and ^{26}Mg. Energies, pairing correlations, rms radii, and quadrupole moments are compared with experimental data. The effect of particle-number fluctuation on the intrinsic wave function and on the properties of the rotational states is investigated. The particle-number fluctuation turns out to be quite important for the description of the rotational levels, whereas it has only negligible effect on the properties of the intrinsic wave function. (auth)

4047 SPECTROSCOPIC FACTORS OF γ-VIBRATIONAL-LIKE STATES IN ODD-A s–d SHELL NUCLEI. Roepke, H.; Glattes, V. (Univ., Freiburg). Phys. Lett.; 41B: No. 5, 565-7 (30 Oct 1972).

Spectroscopic factors of γ-vibrational-like states in $|T_z| = \frac{1}{2}$, A ≈ 23, 25, 27 nuclides are discussed from a microscopic point of view. A different behavior is found for 4n + 3 and 4n + 1 nuclei, in qualitative agreement with experiment. (auth)

4048 HALF-LIFE OF THE NEW ISOTOPE ^{32}Na; OBSERVATION OF ^{33}Na AND OTHER NEW ISOTOPES PRODUCED IN THE REACTION OF HIGH-ENERGY PROTONS ON U. Klapisch, R.; Thibault, C.; Poskanzer, A. M.; (and others) (Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse, Orsay, France). Phys. Rev. Lett.; 29: No. 18, 1254-7(30 Oct 1972).

With an improved on-line mass spectrometer, by means of the reaction of 24-GeV protons on uranium, the very neutron-rich isotope ^{32}Na was discovered and its half-life measured. The same reaction was used to produce the new isotopes ^{33}Na, $^{48-50}K$, and $^{227,228}Fr$. There is evidence for shell effects in the cross sections of the new sodium isotopes. (auth)

4049 M1 TRANSITIONS IN THE ISOSPIN DOUBLET A = 33. Bini, M.; Bizzeti, P. G.; Bizzeti-Sona, A. M. (Univ., Florence). Nuovo Cim.; 12A: No. 1, 215-20(1 Nov 1972).

The mean life of the ^{33}Cl 1985-keV ($\frac{5}{2}^+$) second excited level, $\tau = (94^{+14}_{-20})$ fs, and a lower limit $\tau \geq 250$ fs for the 810-keV ($\frac{1}{2}^+$) first excited level were measured with the Doppler-shift attenuation method by means of the reaction $^{32}S(p,\gamma)^{33}Cl$. The strengths of the $\frac{5}{2}^+ \rightarrow \frac{3}{2}^+$ g.s. transitions were compared in mirror nuclei ^{33}Cl and ^{33}S. The relative importance of the isoscalar and of the two isovector terms in the M1 transition amplitudes was obtained from β and M1 strengths in analog transitions. (2 figures, 2 tables) (auth)

4050 DIFFERENTIAL CROSS SECTIONS FOR ELASTIC SCATTERING OF LOW-ENERGY PROTONS FROM ^{24}Mg AND ^{26}Mg. Wang, W. N.; Lin, E. K.; Tung, C. L. (Physics Research Center, Hsinchu, Taiwan). Chin. J. Phys. (Taiwan); 10: No. 1, 1-6(Apr 1972).

The $^{24,26}Mg(p,p)^{24,26}Mg$ differential cross sections have been measured at E_p = 1.5 to 3.0 MeV by using targets of high enrichment in ^{24}Mg and ^{26}Mg, respectively. Excitation functions for the elastic scattering of protons have been obtained at center-of-mass scattering angles near 130° and 150° for proton energies between 1.5 and 3.0 MeV. Scattering angular distributions were measured at three energies in this range. The elastic scattering excitation functions exhibit conspicuous resonances at E_p = 1.63 MeV for the $^{24}Mg(p,p)$ case and at E_p = 2.03 MeV for the $^{26}Mg(p,p)$ case. The measured angular distributions show a characteristic of symmetry about 90° at resonance and a characteristic of Coulomb scattering at non-resonant energies. Differential cross sections for elastic scattering of protons from ^{26}Mg were found to be somewhat larger than those from ^{24}Mg in the energy range investigated. (auth)

4051 STUDY OF EXCITED STATES OF THE ^{35}Cl NUCLEUS. I. EXCITATION FUNCTION OF THE $^{34}S(p,\gamma)^{35}Cl$ REACTION, ENERGY, AND BRANCHING RATIOS OF ^{35}Cl LEVELS. Hubert, P.; Aleonard, M. M.; Castera, D.; Leccia, F.; Mennrath, P. (CEN, Gradignan, France). Nucl. Phys.; A195: No. 2, 485-501 (1972). (In French).

Energies and resonance strengths were determined for fifty-nine $^{34}S(p,\gamma)^{35}Cl$ resonances in the range E_p = 700 to 2100 keV. The measurement of the excitation function near E_p = 1510 keV, with a very thin target, shows that a strong resonance, already identified as an isobaric analog resonance, is split into two components. Decay schemes of forty-eight resonances were studied by means of a 60 cm^3 Ge(Li) detector. Energies and γ branchings of all bound states are given. Six previously unreported levels at excitations E_x = 4173.0 ± 0.6, 4838 ± 3, 4853 ± 2, 5587 ± 3, 5802 ± 5, and 6489 ± 5 keV were found. The reaction Q value is 6367.4 ± 1.6 keV. (auth)

4052 STUDY OF EXCITED STATES OF ^{35}Cl. II. MEAN LIFETIMES. Hubert, P.; Aleonard, M. M.; Castera, D.; Leccia, F.; Mennrath, P. (CEN, Gradignan, France). Nucl. Phys.; A195: No. 2, 502-12(1972). (In French).

Doppler-shift measurements of γ rays from the $^{34}S(p,\gamma)^{35}Cl$ reaction led to the mean lifetimes τ_m = 175 ± 20, 500 ± 100, 255 ± 65, 21 ± 3, 22 ± 3, ≧2000, 7 ± 2, 390 ± 110, 13 ± 4, 22 ± 3, 55 ± 6, 32 ± 5, ≧600, 270 ± 95, ≦6, and 7 ± 2 fs for the levels 1.22, 1.76, 2.65, 2.69, 3.00, 3.16, 3.92, 3.94, 3.97, 4.06, 4.17, 4.18, 4.35, 4.77, 4.85, and 4.88 MeV, respectively. Spins and parities of some levels are discussed. The experimental energy spectrum and electromagnetic transition rates are compared with those calculated from different nuclear models. (1 figure, 4 tables) (36 references) (auth)

4053 ELASTIC SCATTERING OF ^{3}He FROM ^{9}Be, ^{10}B, ^{11}B, ^{24}Mg, ^{25}Mg, ^{26}Mg, AND ^{27}Al. Buffa, A. J. Jr.; Brussel, M. K. (Univ. of Illinois, Urbana). Nucl. Phys.; A195: No. 2, 545-58 (1972).

Elastic scattering angular distributions of ^{3}He particles from ^{9}Be, ^{10}B, ^{11}B, ^{24}Mg, ^{25}Mg, ^{26}Mg, and ^{27}Al at $E(^{3}He) \approx 13$ to 27 MeV were measured, and some of the representative results are reported. In most cases the angular range of the measured cross sections was from 8° to 150° (lab). The results were analyzed in terms of a six-parameter optical model and are compared with previous work. (auth)

Nuclear Properties and Reactions, 39 ≤ A ≤ 58

Refer also to abstracts 3633, 4015, 4037, 4069, 4073, 4084, 4107, 4114, 4188, 4190, 4192, and 4194.

4054 (TID-26183) HIGH ENERGY NUCLEAR INTERACTIONS WITH MATTER AND NUCLEAR PROCESSES IN NATURE.

Annual Report, July 1, 1971–June 30, 1972. Schaeffer, O. A. (State Univ. of New York, Stony Brook. Dept. of Earth and Space Sciences). [nd]. Contract AT(11-1)-3080. 6p. Dep. NTIS.

Proton production cross sections have been determined for stable and radioactive rare gases for vanadium, barium, uranium, and iron targets. Studies indicate that by the use of a laser beam it is possible to extract the rare gases from sub milligram samples. A new method of counting ^{36}Cl in the gas phase and CH_3Cl was developed and applied to ^{36}Cl produced by protons in iron targets and in meteorites. (auth)

4055 DECAY OF ^{48}Sc. Singh, H.; Tikku, V. K.; Sethi, B.; Mukherjee, S. K. (Saha Inst. of Nuclear Physics, Calcutta). Radiochem. Radioanal. Lett.; 11: No. 2, 137-45(25 Aug 1972).

The irradiation of ^{51}V with 14.7-MeV neutrons was found to produce 5.8-min, 3-h, and 44-h activities, inferred from the decay of electrons. The 3-h activity is tentatively assigned to a new isomer of ^{48}Sc. The γ rays following the β-decay of 44-h ^{48}Sc were measured using Ge(Li) and NaI(Tl) spectrometers in single and coincidence experiments. The energies (intensities) of the γ rays (keV) are: 174.9 ± 0.2 (7.8 ± 0.8), 984.3 ± 0.2 (100), 1038.6 ± 0.2 (95 ± 4), 1213.4 ± 0.4 (2.5 ± 0.3), 1313.3 ± 0.3 (100). The 1213.4-keV transition has been confirmed to be a cross-over transition from the 3511.1-keV level to the 2297.6-keV level of ^{48}Ti. The results are incorporated into a modified decay scheme of ^{48}Sc. (auth)

4056 EXCITATION OF ROTATIONAL BANDS IN ^{40}Ca OBSERVED IN THE REACTION $^{36}Ar(^{16}O,^{12}C)$. Braun-Munzinger, P. (Max-Planck Institut fuer Kernphysik, Heidelberg); Gelbke, C. K.; Grama, N.; (and others). Phys. Rev. Lett.; 29: No. 18, 1261-4 (30 Oct 1972).

Levels strongly populated in the reaction $^{36}Ar(^{16}O,^{12}C)^{40}Ca$ are compared with predictions for the lowest (oblate) 4p–4h rotational band in ^{40}Ca. (auth)

4057 GIANT RESONANCES IN THE HIGH-ENERGY INELASTIC SCATTERING CONTINUUM. Lewis, M. B. (Oak Ridge, National Lab., Tenn.). Phys. Rev. Lett.; 29: No. 18, 1257-60(30 Oct 1972).

The details of the structure previously observed in the high-energy proton-scattering continuum are inspected for collective multipole contributions. Evidence is shown that, in the $E^* \approx$ 10 to 25 MeV excitation region of the ^{40}Ca continuum, at least dipole, quadrupole, and octupole excitations contribute to the structure of the cross section $[\sigma(\theta,E^*)]$. While the dipole and quadrupole strengths exhaust most of their corresponding sum rules, the octupole component does not. The possible nature of the less structured component at this continuum region is discussed. (auth)

4058 ENERGY DEPENDENCE OF ELASTIC α-PARTICLE SCATTERING: MICROSCOPIC MODEL. Lerner, G. M. (Texas A and M Univ., College Station); Hiebert, J. C.; Rutledge, L. L. Jr.; Bernstein, A. M. Phys. Rev., C.; 6: No. 4, 1254-7(Oct 1972).

The energy dependence of elastic α scattering from ^{40}Ca between 39.6 and 115.4 MeV is determined using a microscopic optical model. The agreement between theory and experiment improves as the energy increases. Both the real and imaginary parts of the optical potential are well described by a strength depending linearly on energy. For the real part the slope is about half the corresponding value for proton scattering; no theoretical estimates of this quantity are presently available. (2 figures, 1 table) (auth)

4059 ANOMALOUS BACKWARD α SCATTERING. Stock, R. (Univ., Marburg, Ger.); Gaul, G.; Santo, R.; (and others). Phys. Rev., C.; 6: No. 4, 1226-34(Oct 1972).

The elastic α scattering to backward angles was studied for $^{40,42,44,48}Ca$ between 40.7 and 72.3 MeV. The cross sections for ^{40}Ca are larger than those for the higher isotopes up to the highest energies. They show backward increases that disappear above 50 MeV. The enhancement factor for ^{40}Ca over $^{42,44}Ca$ varies smoothly with energy. ^{48}Ca also shows a backward cross-section enhancement over $^{42,44}Ca$. α-cluster rotational bands in the ^{44}Ti compound state, four-nucleon correlations in ^{40}Ca, and the l-dependent optical model are discussed as approaches to understand the anomaly. The rotator model appears to agree qualitatively with the experimental data. It involves rotational bands extending at least up to J = 16 in ^{44}Ti. (7 figures) (auth)

4060 INVESTIGATION OF ASYMMETRIC SHAPES FOR THE EVEN–EVEN 2p–1f SHELL NUCLEI. Chandra, Harish; Rustgi, M. L. (State Univ. of New York, Buffalo). Phys. Rev., C.; 6: No. 4, 1281-92(Oct 1972).

An investigation for the existence of asymmetric shapes having symmetry about the X–Y, Y–Z, and Z–X planes is carried out for the even–even 2p–1f shell nuclei by using the self-consistent Hartree–Fock (HF) and Hartree–Fock–Bogolyubov (HFB) procedures. The results for a central Yukawa interaction and core-polarized Kuo–Brown matrix elements for the Hamada–Johnston interaction are reported. It is found that for those N = Z nuclei which favor triaxial shape, the HF gap is increased considerably as compared to their corresponding HF gap for the axially symmetric shape. For N ≠ Z nuclei, although the HF approach may yield triaxial solutions with somewhat lower energies as compared to the axial HF results, these solutions converge to their respective HFB shapes having axis of symmetry in the presence of pairing. For those cases where the HFB approximation yields triaxial solution with minimum energy, the gain in binding energy due to pairing correlations is found to be compensated by the decrease in the HF contribution to the HFB energy, resulting in no over-all gain in binding over the corresponding triaxial HF solution. The pairing energy, intrinsic quadrupole moments, and pickup strengths of those nuclei which favor triaxial solutions are compared with the corresponding axially symmetric results. (auth)

4061 ELECTROMAGNETIC TRANSITIONS FOR ^{16}O, ^{40}Ca, ^{48}Ca, AND ^{208}Pb IN THE RENORMALIZED RANDOM-PHASE APPROXIMATION. Eckhart, G. (Univ., Munich); Weigel, M. Phys. Rev., C.; 6: No. 4, 1435-40(Oct 1972).

Transition rates and mean lifetimes for odd-parity levels of ^{16}O, ^{40}Ca, ^{48}Ca, and ^{208}Pb are obtained by using the wave functions of a renormalized random-phase approximation (RPA) treatment. For ^{208}Pb the even-parity levels are also included. (auth)

4062 E0 DECAY OF THE 2561-keV 0^+ LEVEL OF ^{54}Fe. Warburton, E. K.; Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C.; 6: No. 4, 1224-5(Oct 1972).

The branching ratio of the 0^+ state of ^{54}Fe at 2561 keV for decay by e^+–e^- pair emission to the 0^+ ground state was measured to be (0.17 ± 0.025)%. The lifetime of this third excited state of ^{54}Fe is not known; the main decay mode is by E2 decay to the 1408-keV 2^+ first excited state. In addition, γ-ray spectra were measured with a Ge(Li) detector, and excitation energies and branching ratios were determined for levels up to 3.834 MeV. (1 figure, 1 table) (auth)

4063 $d_{\frac{5}{2}}$ HOLE STRENGTH IN THE GROUND STATE OF ^{44}Ca. Von der Decken, A.; Dehnhard, D.; Goldschmidt, M.; (and others) (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett.; 41B: No. 4, 477-9(16 Oct 1972).

The proton stripping reaction $^{44}Ca(\tau,d)^{45}Sc$ (g.s., 12.4 keV) was studied at $E(^3He)$ = 24 MeV with the Heidelberg Q3D magnetic spectrograph. The strength of the transition to the $(d_{\frac{5}{2}})$ hole state in ^{45}Sc was found to be $(2J_f + 1)C^2S_p = 1.9$. (auth)

4064 MEASUREMENT OF SHORT NUCLEAR LIFETIMES IN ^{40}Ca AND ^{48}Ca. Tape, J. W. New Brunswick, N. J.; Rutgers–The State Univ. (1972). 207p. University Microfilms Order No. 72-27,599.

Thesis.

The lifetimes, energies, decay modes, and proton–gamma ray angular correlations of the first five excited states of ^{48}Ca were measured. In addition, the lifetimes of two excited states in ^{40}Ca were determined. The delayed-coincidence technique was used to obtain the lifetimes of the 3.737- and 4.492-MeV states of ^{40}Ca and the 4.284- and 5.152-MeV states of ^{48}Ca. The lifetimes of the 3.832-, 4.507-, and 4.613-MeV states of ^{48}Ca were determined by using the Doppler-shift-attenuation method. The (p,p') reaction was used to excite the states in all cases. The ^{40}Ca 3.737-MeV (3^-) state lifetime, τ = 59 ± 5 ps, was compared to previous indirect measurements of the 3^- transition strength; only some of the recent electron scattering work agrees with the present result. Theoretical calculations of the E3 transition strength using the random phase approximation (RPA) are in fair agreement with the experimental value. Theoretical and experimental B(E2) values for transitions between odd-parity states are in good agreement. The energies, spins, and lifetimes obtained in the ^{48}Ca measurements are 3832.3 ± 0.5 keV, 2^+, 0.053 ± 0.024 ps; 4283.9 ± 0.6 keV, 0^+, 322 ± 16 ps; 4507.3 ± 0.6 keV, 3^-, $8.8^{+5.5}_{-2.8}$ ps; 4612.6 ± 0.6 keV, $3^{(+)}$, $1.8^{+0.7}_{-0.5}$ ps; 5152.3 ± 1.0 keV, (5^-), 2210 ± 40 ps. The odd-parity states are well described by the RPA; however, shell-model calculations of the even-parity spectrum of ^{48}Ca involving only neutron excitations are not particularly successful—core excitations are indicated to be important. (TSS) (Diss. Abstr. Int., B)

4065 ELASTIC SCATTERING OF ^{16}O AND ^{18}O BY EVEN Ca ISOTOPES, ^{52}Cr, AND ^{62}Ni AT INCIDENT ENERGIES NEAR THE COULOMB BARRIER. Eisen, Y.; Eisenstein, R. A.; Smi-

lansky, U.; Vager, Z. (Weizmann Inst. of Science, Rehovot, Israel). Nucl. Phys.; A195: No. 2, 513-26(1972).

The excitation functions measured in this experiment show marked differences between ^{16}O and ^{18}O. The experimental data are analyzed and discussed by means of an incoming-wave boundary-condition method (IWB). (12 figures, 1 table) (auth)

4066 ENERGY LEVELS OF ^{49}V FROM $^{49}Ti(p,n)^{49}V$. Malan, J. G.; Barnard, E.; De Villiers, J. A. M.; Tepel, J. W.; Van Der Merwe, P. (Atomic Energy Board, Pelindaba, S. Afr.). Nucl. Phys.; A195: No. 2, 596-608(1972).

Energy levels of ^{49}V were populated by the $^{49}Ti(p,n)$ reaction at proton energies between 2.03 and 3.25 MeV. Spins were determined within the framework of the statistical theory from the angular distribution of de-excitation γ rays measured at five incident proton energies. Excitation strengths and decay branching ratios of the various levels were taken into account. A complete level and decay scheme for ^{49}V up to an excitation of 1.7 MeV is presented. (6 figures, 4 tables) (auth)

Nuclear Properties and Reactions, 59 ≤ A ≤ 89

Refer also to abstracts 4034, 4060, 4089, 4107, 4114, 4184, 4190, 4192, 4193, and 4195.

4067 p WAVE NEUTRON CAPTURE IN MEDIUM AND HEAVY WEIGHT NUCLEI. Siddappa, K.; Murty, M. S.; Rao, J. R. (Univ. of Andhra, Waltair, India). J. Phys., A (London); 5: No. 6, 877-80(Jun 1972).

A systematic investigation of the average neutron capture cross sections at 25 keV was undertaken to study the structure of giant resonances in the p-wave neutron strength functions. As a part of this program and to fill in the gaps in the existing cross section data, radiative capture cross sections for the following isotopes were measured: ^{74}Se, ^{78}Se, ^{84}Sr, ^{109}Ag, ^{122}Te, ^{159}Tb, ^{169}Tm, ^{174}Yb, ^{176}Yb, ^{178}Hf, ^{179}Hf and ^{192}Os. The activation method and absolute gamma counting technique were employed. The new results are reported with a discussion of the p-wave neutron capture in these nuclei. (auth)

4068 THIN-TARGET CROSS SECTIONS FOR SOME Cr, Mn, Fe, Co, Ni, AND Zn NUCLIDES PRODUCED IN COPPER BY 82- TO 416-MeV PROTONS. Heydegger, H. R.; Garrett, C. K.; Van Ginneken, A. (Univ. of Chicago). Phys. Rev., C.; 6: No. 4, 1235-40(Oct 1972).

Thin-target cross sections were determined by radiochemical means for the production of the radionuclides ^{65}Zn, ^{63}Ni, ^{56}Ni, ^{60}Co, ^{58}Co, ^{57}Co, ^{56}Co, ^{59}Fe, ^{55}Fe, ^{54}Mn, ^{52}Mn, and ^{51}Cr by 82-, 111-, 187-, 283-, and 416-MeV protons incident on natural copper. The experimental results are compared with values in the literature, expected trends in the excitation functions, and values calculated via empirical formulas and Monte Carlo treatments. (1 figure, 2 tables) (auth)

4069 STUDY OF (^3He,t) REACTIONS AT 70 MeV TO ISOBARIC ANALOG STATES OF ^{50}Cr, ^{62}Ni, AND ^{90}Zr. Hinrichs, R. A.; Show, D. L. (Michigan State Univ., East Lansing). Phys. Rev., C.; 6: No. 4, 1257-64(Oct 1972).

The analysis of (^3He,t) reactions at 70 MeV to isobaric analog ground states of ^{50}Cr, ^{62}Ni, and ^{90}Zr shows an energy dependence in the extracted isospin-dependent interaction strengths consistent with results at lower energies; the interaction strengths are approximately 50% smaller than at lower bombarding energies. The shapes of the form factors in a macroscopic analysis are nuclei dependent. A mass-three optical potential with a real strength of about 110 MeV and a volume imaginary term is strongly preferred in the (^3He,t) calculations. (6 figures, 4 tables). (auth)

4070 STATES OF ^{86}Rb: THE $^{87}Rb(d,t)^{86}Rb$ REACTION. Holden, J. E.; Kolata, J. J.; Daehnick, W. W. (Univ. of Pittsburgh). Phys. Rev., C.; 6: No. 4, 1305-11(Oct 1972).

The states of ^{86}Rb were studied using the $^{87}Rb(d,t)^{86}Rb$ reaction at 17.5 MeV incident energy. Spectra were obtained using an Enge split-pole magnetic spectrograph; over-all energy resolution was 9 keV. Angular distributions were obtained from 9 to 60° laboratory angle for 25 levels up to 2 MeV excitation. Comparison with distorted-wave Born-approximation calculations yielded unique l-value assignments for 18 transitions; absolute spectroscopic factors were also extracted. Implications about the structure of the low-lying states are pointed out. The significant excitation of the $J^\pi = 2^-$ ground state of ^{86}Rb indicates weak $3s_{\frac{1}{2}}$ and $2d_{\frac{3}{2}}$ admixtures in the ^{87}Rb ground state. (auth)

4071 STATES OF ^{86}Rb: THE $^{88}Sr(d,\alpha)^{86}Rb$ REACTION. Kolata, J. J.; Daehnick, W. W.; Holden, J. E. (Univ. of Pittsburgh). Phys. Rev., C.; 6: No. 4, 1312-21(Oct 1972).

The $^{88}Sr(d,\alpha)^{86}Rb$ reaction was studied with 17.00-MeV deuterons. Energy resolution of 11 keV was obtained using an Enge split-pole spectrograph. Accurate excitation energies (±0.15%) were measured for more than 35 states up to an excitation energy of 3.3 MeV in the residual nucleus. Differential cross sections were obtained for most of the ^{86}Rb states for $12.5° \leq \theta \leq 65°$, and compared with distorted-wave calculations. The deduced L-transfer values allowed the assignment of a narrow range of J^π values to 25 of these states. Several unique spin assignments were possible. Microscopic-model calculations were performed for several of the low-lying negative parity states in ^{86}Rb, using simple two-component wave functions empirically derived from $^{87}Rb(d,t)$ spectroscopic factors. The predictions agreed reasonably well with the experimental (d,α) data for both the relative magnitudes and the shapes of the angular distributions, except for the $J^\pi = 2^-$ ground state. (6 figures, 4 tables). (auth)

4072 RADIATIVE PION ABSORPTION IN COMPLEX NUCLEI. Guy, R. (Univ. of Wisconsin, Oshkosh). Nuovo Cim.; 11A: No. 4, 1006-14(21 Oct 1972).

The process in which the nuclear absorption of a bound negative pion leads to the emission of a high-energy photon is considered for the cases of nickel and tin. It is confirmed that this process will preferentially excite spin–isospin states in the final nucleus that are the isobaric analogs of states in the giant-resonance region of the initial nucleus. The distribution of spin–isospin strength among the states considered is presented, and it is found that the strength is considerably less fragmented than was the case for radiative pion absorption in calcium and zirconium. (2 figures, 4 tables) (auth)

4073 RADIOISOTOPE PRODUCTION RATES BY MUON CAPTURE. Heusser, G.; Kirsten, T. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Nucl. Phys.; A195: No. 2, 369-78(1972).

Radioisotopes induced by muon capture in Fe, Ni, Co, Mg, and Al were measured by low-level γ-ray spectrometry. The intensity of the stopped negative muons was determined by the activity of the Ni target, which corresponds to 80% of the captured muons. Yields derived from the radioisotope concentrations compare favorably with calculations following a model of Singer. Interference with neutron-induced yields is minor. The neutron flux measured by two (n,2n) reaction products can be accounted for by the capture process itself. The measured and calculated neutron multiplicities for Fe group nuclei range from 15 to 30%, 50 to 60%, 10 to 20%, and 0.5 to 10%, for 0, 1, 2, and 3 neutrons emitted per captured muon, respectively. (4 figures, 2 tables, 26 references) (auth)

4074 ELECTRODISINTEGRATION OF ^{12}C, ^{63}Cu, AND ^{107}Ag BY ELECTRONS AND POSITRONS. Kuhl, G.; Kneissl, U. (Justus Liebig Univ.; Giessen, Ger.). Nucl. Phys.; A195: No. 2, 559-65(1972).

Absolute cross sections for the electrodisintegration of ^{12}C, ^{63}Cu, and ^{107}Ag by electrons and positrons were measured in the energy range from 20 to 30 MeV. The cross sections were determined from the induced activities. The measured cross-section ratio σ^-/σ^+ is not equal to 1 and increases with Z. This is in contradiction to the Born-approximation calculations of the virtual-photon spectrum. (4 figures) (auth)

Nuclear Properties and Reactions, 90 ≤ A ≤ 149

Refer also to abstracts 3847, 4034, 4054, 4067, 4069, 4072, 4074, 4105, 4107, 4168, 4190, and 4193.

4075 (FRNC-TH-256) ORDERED STATES IN NUCLEAR MOMENT SYSTEMS. Chau, Vu Hoang (Paris Univ., Orsay (France)). 1970. 115p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The ordered states which can arise when a system of interacting nuclear moments (described by the H_D Hamiltonian) is brought to very low temperatures were studied. From the experimental point of view, the cooling is initially effected by polarizing the magnetic moments, using the solid effect, in an intense magnetic field. Adiabatic demagnetization in a rotating frame of reference is subsequently employed. Under these conditions the interaction Hamiltonian transforms into dipolar truncated Hamiltonian H'_D. From the theoretical point of view, the calculations have established three cases for which the antiferromagnetic states can exist. The respective critical points were determined using two different methods. The experimental results presented are only the beginning of a more complete experimental verification. (France)

4076 (JINR-P1-6557) INVESTIGATION OF FAST PION INTERACTION PROCESS WITH XENON NUCLEI. Slovinskii, B.; Strugal'skii, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The results of an investigation of π^0 meson and slow π^+ meson production and proton emission processes in $\pi-$Xe interactions at 2.34, 5, and 9 GeV/c are presented. The conclusion on the existence of a quasielementary interaction class characterized by the minimal numbers of secondary charged particles is drawn. (auth)

4077 FOUR-NUCLEON TRANSFER FROM ^{16}O TO ^{90}Zr NEAR THE COULOMB BARRIER. Bohn, H. (Univ., Munich); Daniel, Gisela; Maier, M. R.; (and others). Phys. Rev. Lett.; 29: No. 19, 1337-40(6 Nov 1972).

The transfer of two neutrons and two protons is found to be the dominant reaction process in $^{16}O + {}^{90}Zr$ near the Coulomb barrier. The reaction was identified from γ-ray spectra measured in coincidence with backward-angle charged particles. A band of excited states in the residual nucleus is found to be selectively populated. The energy dependence of the centroid energy of this band is studied and compared with theories of sub-Coulomb transfer reactions. (2 figures, 1 table). (auth)

4078 LEVEL PROPERTIES OF ^{94}Mo, ^{98}Mo, AND ^{100}Mo INVESTIGATED VIA MULTIPLE COULOMB EXCITATION. Barrette, J.; Barrette, M.; Boutard, A.; (and others) (Univ. de Montreal). Phys. Rev., C.; 6: No. 4, 1339-47(Oct 1972).

The low-lying states of ^{94,98,100}Mo were investigated via multiple Coulomb excitation effected with 7.2-MeV α particles and 35- to 44.8 MeV oxygen projectiles. In the three isotopes studied, 2^+ and 4^+ levels were excited up to 2.1 MeV. The double E2 excitation of a 0^+ level at 694.4 keV in ^{100}Mo, very close in energy to the first 2^+ excited state, was observed. The E2 transition between the $0^{+\prime}$ level and the first 2^+ state is strongly enhanced, i.e., B(E2; $0^{+\prime} \rightarrow 2^+$)/B(E2; $2^+ \rightarrow 0^+$) = 1.8 ± 0.3. The values obtained for the ratio B(E2; $2^{+\prime} \rightarrow 2^+$)/B(E2; $2^+ \rightarrow 0^+$) and the ratio B(E2; $4^+ \rightarrow 2^+$)/B(E2; $2^+ \rightarrow 0^+$) are 2.6 ± 0.6, 2.5 ± 0.4, 1.69 ± 0.22 and 1.53 ± 0.24, 2.3 ± 0.3, 1.85 ± 0.19, respectively, for ^{94}Mo, ^{98}Mo, and ^{100}Mo. States at 2533.7, 2017.6, and 1908.1 keV were excited in ^{94}Mo, ^{98}Mo, and ^{100}Mo, respectively. These states are interpreted to be the result of direct E3 Coulomb excitation. Their B(E3,$0^+ \rightarrow 3^-$) values are 6.2 ± 1.2 (^{94}Mo), 13.3 ± 1.3 (^{98}Mo), and 13.2 ± 1.7 (^{100}Mo) × 10^{-2} e^2b^3, which represent enhancements of 17, 33, and 32, respectively. (auth)

4079 MEASUREMENT OF THE STATIC QUADRUPOLE MOMENT OF THE FIRST 2^+ STATE IN ^{108}Pd BY HEAVY-ION COULOMB EXCITATION AND A DISCUSSION OF THE HIGHER-STATE INTERFERENCE. Lutz, W. R.; Thompson, J. A.; Scharenberg, R. P.; Larsen, R. D. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C.; 6: No. 4, 1385-90(Oct 1972).

The quadrupole moment of the 0.434-MeV 2^+ state in ^{108}Pd was measured by detecting the de-excitation γ ray following Coulomb excitation in coincidence with scattered ^{32}S ions. If excitation via the second 2^+ state interferes constructively with the direct excitation of the first 2^+ state, thus increasing the excitation probability of the first 2^+ state, $Q_{2+} = -0.51 \pm 0.06$ b. If the interference is destructive, $Q_{2+} = -0.30 \pm 0.06$ b. An attempt to determine the sign of the interference by measuring the energy dependence of the reorientation effect is also discussed. (8 figures, 1 table). (auth)

4080 IN-BEAM INTERNAL-CONVERSION ELECTRONS FROM ^{92}Mo + p. Moore, C. Fred; Hoffmann, G. W.; Fitch, J. F.; Coker, W. R. (Univ. of Texas, Austin). Phys. Rev., C.; 6: No. 4, 1391-3(Oct 1972).

An in-beam electron spectrometer was used to identify internal-conversion transitions resulting from proton bombardment of ^{92}Mo at 8.0 and 11.0 MeV. (2 figures, 1 table). (auth)

4081 COMMENT ON NUCLEAR RAMAN SCATTERING BY DEFORMED NUCLEI IN THE GIANT-RESONANCE REGION. Arenhoevel, Hartmuth (Max-Planck-Institut fuer Chemie, Mainz). Phys. Rev., C.; 6: No. 4, 1449-52(Oct 1972).

Discrepancies between experimental results on nuclear Raman scattering in the giant-resonance region and theoretical predictions are discussed in the light of possible nonresonating contributions from direct transitions into the continuum. It is estimated that a 10 to 15% contribution may remove the existing differences. (1 figure). (auth)

4082 SEARCH FOR THE 2.37-MeV γ RAY FROM THE ^{94}Zr(n,n'γ) REACTION. Tessler, G.; Glickstein, S. S. (Bettis Atomic Power Lab., West Mifflin, Pa.). Phys. Rev., C.; 6: No. 4, 1430-3(Oct 1972).

A search was made for a 2.37-MeV γ ray by using the ^{94}Zr (n,n'γ) reaction at an incident neutron energy of 5 MeV in an attempt to observe the 2.37-MeV (2^+) level seen in ^{92}Zr(t,p)^{94}Zr and ^{96}Zr(p,t)^{94}Zr reaction studies and predicted in an earlier ^{94}Zr (n,n'$\gamma\gamma$) experiment. This γ ray was not observed. Other possible decay modes of the 2.37-MeV (2^+) level were looked for and ruled out except for the unlikely case of the level decaying to several levels in such a way that no one level receives an appreciable amount of the decay. The puzzle thus arises that the ^{94}Zr(n,n'γ) ^{94}Zr reaction excites a 4^+ level at 2.336 MeV not seen in the ^{92}Zr(t,p)^{94}Zr and ^{96}Zr(p,t)^{94}Zr reactions, while the (t,p) and (p,t) reactions excite a 2^+ level at 2.37 MeV not observed in the (n,n'γ) reaction. (4 figures). (auth)

4083 INELASTIC EFFECTS IN APPROXIMATE THREE-BODY AMPLITUDES. Shanley, Paul E. (Univ. of Notre Dame, Ind.). Phys. Rev., C.; 6: No. 4, 1445-7(Oct 1972).

A simple method is described for including the effect of bound-state breakup in the treatment of bound-state elastic scattering in terms of an effective two-body interaction. Applications to the four-body problem and to the treatment of deuteron-nucleus scattering are discussed. (3 figures). (auth)

4084 INFLUENCE OF CHEMICAL ENVIRONMENT ON M1 INTERNAL CONVERSION RATES AND THEIR CONNECTION WITH THE MOESSBAUER ISOMER SHIFT. Raff, U.; Alder, K.; Baur, G. (Univ., Basel). Helv. Phys. Acta; 45: No. 3, 427-39 (31 Aug 1972).

By measuring the change in decay rate $\Delta\lambda/\lambda$ for M1 transitions and the corresponding Moessbauer isomer shift it is possible to extract the change of nuclear charge radius $\delta R/R$. Numerical results are given for ^{119}Sn (23.87 keV), ^{57}Fe (14.4 keV) and ^{195}Pt (99 keV). (auth)

4085 POSITRON BRANCHING IN THE DECAY OF ^{143}Sm, ^{141}Nd, AND ^{140}Pr. Evans, J. L.; Cooper, J. R.; Moore, D. M.; Alford, W. L. (Auburn Univ., Ala.). Phys. Rev., C; 6: No. 4, 1372-4(Oct 1972).

The nuclides ^{143}Sm, ^{141}Nd, and ^{140}Pr were prepared by the (n,2n) reaction by using energetic neutrons produced by deuteron bombardment of tritium and lithium targets. A comparison of K x rays and annihilation radiation from each nuclide was made by means of a thin-window NaI detector. By using theoretical ratios of K electron capture to total electron capture, percentages of positron emission for ^{143}Sm, ^{141}Nd, and ^{140}Pr were found to be 40.0 ± 2.0, 2.72 ± 0.20, and 48.7 ± 2.2, respectively. (1 figure, 1 table) (auth)

4086 (p,t) EXCITATIONS OF REMOVAL AND ADDITION TYPES OF QUADRUPOLE-PAIRING VIBRATIONAL STATES IN EVEN Nd ISOTOPES. Yagi, K. (Osaka Univ.); Sato, K.; Aoki, Y.; Udagawa, T.; Tamura, T. Phys. Rev. Lett.; 29: No. 19, 1334-7(6 Nov 1972).

Strong L = 2 transitions to the removal type of quadrupole-pairing vibrational states with Q = −(8 to 10) MeV, observed in (p,t) reactions on all stable Nd isotopes with 52-MeV protons, are shown to be well accounted for by one-step distorted-wave Born-approximation calculations. Compared with these, the transitions to the 2_1^+ (addition type of quadrupole pairing) states of N ≥ 82 isotopes, which are found to be much weaker and have quite different angular distributions, are shown to be reasonably accounted for in terms of two-step coupled-channel Born-approximation calculations. (3 figures) (auth)

4087 PROTON SPIN-FLIP PROBABILITY IN INELASTIC SCATTERING ON ^{120}Sn AND ^{124}Sn AT 30 MeV. Howell, Richard Harry. East Lansing, Mich.; Michigan State Univ. (1972). 110p. University Microfilms Order No. 72-22,231.

Thesis.

Proton spin-flip in the excitation of the first 2^+ states in ^{120}Sn and ^{124}Sn has been measured at 30 MeV using the (p,p'γ) coincidence technique. The data are fit by the DWA collective model using the full Thomas spin-orbit coupling term and by the DWA microscopic model using detailed wave functions and a realistic interaction. These calculations are also compared to published proton angular distribution and asymmetry data on the first excited state in ^{120}Sn at 30 MeV. The effect of including a realistic two body spin-orbit interaction was investigated with respect to these data. The effect of complex coupling was also investigated for these data and published cross section and asymmetry data on the first excited states of ^{208}Pb and ^{58}Ni. Imaginary form factors obtained from the collective model and from a phenomenological microscopic prescription were used. It is concluded that an imaginary term in the form factor can be important. (Diss. Abstr. Int., B)

4088 IN-BEAM MEASUREMENTS OF THE NUCLEAR QUADRUPOLE INTERACTION IN CADMIUM METAL. Bleck, J.; Butt, R.; Haas, H.; Ribbe, W.; Zeitz, W. (Hahn-Meitner Inst.

fuer Kernforschung, Berlin). Phys. Rev. Lett.; 29: No. 20, 1371-4(13 Nov 1972).

A time-differential perturbed angular distribution experiment on the 247-keV level of ^{111}Cd, excited by the (d,p) reaction in ^{110}Cd metal, shows a static quadrupole interaction at high temperatures and pronounced effects of radiation damage at lower temperatures. (auth)

4089 CALCULATED ENERGY LEVELS FOR ^{89}Y, ^{90}Zr, ^{91}Nb, ^{92}Mo, ^{93}Tc, AND ^{94}Ru. Ball, J. B. (Oak Ridge National Lab., Tenn.); McGrory, J. B.; Larsen, J. S. Phys. Lett.; 41B: No. 5, 581-4(30 Oct 1972).

Recent experimental data for the behavior N = 50 nuclei are examined in terms of a model based on an inert ^{88}Sr core. The eleven interaction parameters required to define the shell-model space are determined by fitting 44 experimental energies. (auth)

4090 QUADRUPOLE MOMENTS OF THE FIRST $3/2^-$ AND $5/2^-$ STATES OF ^{109}Ag AND THE PARTICLE–VIBRATOR COUPLING MODEL. Throop, M. J.; Hall, I.; Naquib, I. M.; Thomas, D. J.; Wakefield, B. (Univ. of Liverpool). Phys. Lett.; 41B: No. 5, 585-7(30 Oct 1972).

The static quadrupole moments of the first $3/2^-$ and $5/2^-$ states of ^{109}Ag were measured by Coulomb excitation. The results imply the need to include core anharmonicity in the particle–vibrator coupling model of this nucleus. (auth)

4091 NOTE ON THE FAST NEUTRON CROSS SECTIONS OF PALLADIUM. Smith, A. B.; Lambropoulos, P.; Guenter, P.; Whalen, J. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 49: No. 3, 389-92(Nov 1972).

The neutron total and scattering cross sections of elemental palladium were measured to incident energies of ~ 1.5 MeV. An optical potential was deduced consistent with the present experimental results, with previously reported cross sections at higher energies, and with the minimum in the l = 0 strength function in the region of A ≈ 105. (auth)

4092 RPA METHOD WITH ANGULAR MOMENTUM PROJECTION. Kammuri, T.; Kusuno, S. (Kernforschungsanlage, Juelich, Ger.). Z. Phys.; 255: No. 5, 431-45(1972).

In view of projecting the angular momentum eigenstates out of the intrinsic RPA states, one first studies linear relations between deformed and spherical phonons. By use of these relations, the deformed RPA Hamiltonian can be expressed in terms of the spherical phonons in the form of a displaced harmonic oscillator. The angular momentum projection can be applied to an intrinsic RPA state determined by the reduced Hamiltonian, and the correspondence with the macroscopic deformed phonon model of Lipas et al., can be done at this stage. Two important parameters, the constant term in the linear relations and the strength of the spherical phonon Hamiltonian, are evaluated and compared with the best-fit values obtained by Lipas et al. (auth)

4093 REACTION ^{144}Sm(d,t)^{143}Sm. Jaskola, M. (Inst. of Nuclear Research, Warsaw); Nyboe, K.; Elbek, B. Acta Phys. Pol., B3: No. 5, 643-8(1972).

The levels of ^{143}Sm have been studied by means of the ^{144}Sm(d,t) reaction at bombarding energies of 12.1 MeV and 13.1 MeV. The reaction products were observed by a solid state counter telescope or by a magnetic spectrograph. Levels at 0 keV, 108 keV, 755 keV, and 1104 keV were populated by the (d,t) reaction. The ground state Q-value was found to be −4.262 MeV. Angular distribution measurements are in agreement with the shell model assignments $d_{3/2}$, $s_{1/2}$, $h_{11/2}$ and $d_{5/2}$, respectively, for the neutron hole states. The spectroscopic factors for these states were obtained from a DWBA calculation. (auth)

4094 DECAY OF ^{117}Cd AND ^{117}Cd^m. Gregory, P. R.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 50: No. 17, 2012-26(1 Sep 1972).

The energy levels of ^{117}In were investigated following the β decay of 3.4 h ^{117m}Cd and 2.5 h ^{117g}Cd. Using high resolution Ge(Li) detectors singly and in coincidence, 127 γ transitions were observed. Eighty-five of these transitions were classified by both coincidence data and energy fit, 29 weak transitions by energy fit alone, and 12 remain unclassified. Thirty-seven levels in ^{117}In were established; of these, 24 are low spin states fed from the ground state and 13 are high spin states fed from the isomer. Spin and parity assignments for the newly established levels are discussed. (auth) (Canada)

4095 MAGNETIC MOMENT MEASUREMENT IN ^{125}Te BY IPAC. Badica, T.; Ciortea, C.; Dima, S.; (and others) (Inst. for Atomic Physics, Bucharest). Z. Phys.; 255: No. 5, 390-3 (1972).

The magnetic moment of the 35.5 keV ($3/2^+$) excited state in ^{125}Te was measured in an external magnetic field. The value obtained $\mu = 0.57 \pm 0.07\ \mu_N$ agrees with Mössbauer determinations and Kisslinger-Sorensen calculations. (auth)

4096 RELATIVE MEASUREMENT OF THE LONGITUDINAL β-POLARIZATION OF ^{141}Ce. Poppensieker, K. P.; Quentmeier, A.; Wallek, L. (Univ., Muenster, Ger.). Z. Phys.; 255: No. 5, 405-9(1972). (In German).

The longitudinal polarization of the β-particles of ^{141}Ce was measured. Whereas Lipnik and Sunier predicted a polarization P approximate −0.5 v/c, for an energy E = 400 keV a value P = −(0.91 ± 0.09) v/c is obtained. The dependence of P on the parameter Y is discussed. (auth)

Nuclear Properties and Reactions, 150 ≤ A ≤ 189

Refer also to abstracts 4067, 4086, 4092, and 4107.

4097 (FRNC-TH-255) STUDY OF CONFIGURATION MIXING IN MODERATELY DEFORMED ODD NUCLEI. LEVEL SCHEMES OF ^{187}Ir AND ^{233}Pa. Sebille-Schueck, Claire (Paris Univ., Orsay (France)). 1972. 116p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The disintegration of ^{233}Th was studied, and the level scheme of ^{233}Pa was established up to 1 MeV. Investigations of the Coriolis coupling between the three bands $1/2^+(660)$, $3/2^+(651)$, and $5/2^+(642)$ demonstrated that the intensity of the coupling is such that the levels may be interpreted uniquely using the Coriolis coupling and the ΔN = ±2 coupling. The ^{187}Pt → ^{187}Ir disintegration was studied. The negative parity levels in ^{187}Ir are more numerous than in the other known isotopes of iridium. In particular, the $9/2^-$ level has no analog in the other nuclei. A group of levels having negative parity related to the $11/2$ level appears to be inexplicable in terms of the Nilsson model. This peculiarity seems to be due to the highly deformable nature of this nucleus, which can change its form in these states. (France)

4098 OPTICAL-MODEL INFORMATION PROVIDED BY SCATTERING FROM ALIGNED TARGETS. Parks, D. R. (Stanford Univ., Calif.); Tabor, S. L.; Triplett, B. B. Phys. Rev. Lett.; 29: No. 18, 1264-7(30 Oct 1972).

Data on the scattering of α particles from aligned ^{165}Ho was recorded over the energy range $14 \le E_\alpha \le 23$ MeV. Optical-model calculations are presented. It is shown that the data provide a clear resolution of the optical-model ambiguities found in previous analyses of α scattering from rare earth nuclei. (auth)

4099 PENETRATION MATRIX ELEMENTS IN THE INTERNAL CONVERSION OF THE 150.4-keV TRANSITION IN ^{177}Lu. Agnihotry, A. P.; Gopinathan, K. P. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., C.; 6: No. 4, 1394-8(Oct 1972).

The K- and L-subshell internal-conversion coefficients of the anomalous 150.4-keV transition in ^{177}Lu were measured with a double-focusing electron spectrometer and a Ge(Li) γ-ray spectrometer. The analysis of the results gave the M2 content, Q, as (0.92 ± 0.88)% and the penetration parameters $\lambda_1 = -21.4 \pm 2.3$ and $\lambda_2 = -660 \pm 900$. By using these results along with the known lifetime of the 150.4-keV level, the E1 and M2 γ-ray matrix elements and the $\int \vec{j}_n \cdot \vec{r}$ and the $\int \vec{j}_n \cdot \vec{\nabla}$ type penetration matrix elements were evaluated and compared with those of similar transitions in ^{175}Lu and ^{181}Ta and with the estimates of the Nilsson model. (5 figures, 4 tables). (auth)

4100 LEVELS OF ^{155,157,159,161}Tb EXCITED IN HELIUM-INDUCED SINGLE-PROTON-TRANSFER REACTIONS. Boyno, J. S.; Huizenga, J. R. (Univ. of Rochester, N. Y.). Phys. Rev., C.; 6: No. 4, 1411-24(Oct 1972).

Energy levels of ^{155,157,159,161}Tb were studied through the (^{3}He,d) and (α,t) reactions on ^{154,156,158,160}Gd, run with 25.5-MeV ^{3}He and 27.0-MeV α particles, respectively. Distorted-wave Born-approximation analysis was used to interpret the reaction results, with transferred l values obtained from the comparison of the experimental and theoretical values of the cross-section ratio, $R = d\sigma(^3\text{He,d})/d\sigma(\alpha,t)$. The spectroscopic information obtained was compared to the theoretical predictions of the Nilsson model. Corrective terms added included the Coriolis and pairing interactions. Many of the levels excited were identified as members of rotational bands built on Nilsson single-particle configurations. Identified in all four nuclei are the [411↑], [413↓], [532↑], [404↓], [402↑], and [411↓] Nilsson configurations. Other bands identified are the [541↓] in ^{157,159,161}Tb, the [523↑] in ^{159,161}Tb, the [411↑] γ mixed configuration in ^{155,157,159}Tb, and the [514↑] configuration in ^{155}Tb. (10 figures, 5 tables). (auth)

4101 VALUES OF THE NEUTRON RESONANCE CAPTURE INTEGRAL FOR SOME RARE EARTH ISOTOPES. Rahn, F.; Camarda, H. S.; Hacken, G.; (and others) (Columbia Univ., New York). Nucl. Sci. Eng.; 48: No. 2, 219-21(Jun 1972).

The neutron resonance capture integrals of 22 isotopes of the rare earth elements and tungsten, calculated from resonance parameters, are reported. The values are based on a series of transmission, self-indication, and capture time-of-flight measurements. The results are in fair agreement with previously reported values. (auth)

4102 CORRELATION BETWEEN (n,γ) AND (d,p) REACTIONS IN ^{176}Lu. Fubini, A.; Prosperi, D. (Comitato Nazionale per l'Energia Nucleare, Rome). Lett. Nuovo Cim.; 4: No. 17, 1003-6 (26 Aug 1972).

An attempt was made to find correlations between the (n,γ) and (d,p) strengths in ^{176}Lu. The target, 10 g of natural lutetium, was placed in a thermal neutron flux of $2 \cdot 10^6$ n/cm^2 s. The capture gamma-ray spectrum was measured by a pair spectrometer. A list of energies and intensities of the observed γ rays is reported. A binding energy of 7072.5 ± 1 keV was obtained. (W.D.M.)

4103 ANGULAR CORRELATION MEASUREMENTS IN ^{154}Gd. Goettel, P.; Delang, W.; Seyfarth, H. (Inst. for Neutron Physics, Juelich, Ger.). Z. Phys.; 255: No. 5, 450-8(1972).

The γ−γ angular correlation measurements were performed to determine the mixing parameters δ of some γ-transitions in ^{154}Gd. High energy Compton background could easily be eliminated using a two dimensional data acquisition system. The relative B (E2)-values of (K = 2 → K = 0) interband transitions were determined and compared with collective model predictions. (auth)

4104 PROPERTIES OF INTRINSIC AND ROTATIONAL STATES IN ^{175}Ta. Foin, C. (Institut des Sciences Nucleaires, Grenoble, France); Lindbald, Th.; Skanberg, B.; Ryde, H. Nucl. Phys.; A195: No. 2, 465-84(1972).

High-spin rotational levels in ^{175}Ta were populated in the ^{175}Lu $(\alpha,4n)^{175}$Ta reaction, and the de-excitation γ-ray cascades were studied with the γ−γ coincidence technique. The rotational bands, which are built on the $7/2^+$ [404], $5/2^+$ [402], $9/2^-$ [514], and $1/2^-$ [541] intrinsic states, were identified up to high spin values. The experimental location of the band heads is compared with calculations within a single-particle model, by using a diffuse Woods–Saxon potential. The moment-of-inertia parameters are discussed within the framework of the unified model with pairing and Coriolis interactions included. The gyromagnetic ratio of the core, g_R, is determined from the experimental values of $g_K - g_R$ and the values of g_K predicted by the single-particle model. The analysis of the time distribution of the emitted γ radiation shows, for some transitions within the $9/2^-$ [514] rotational band, a delayed component. It is deduced from the γ−γ coincidence measurements that these delayed components originate from an isomeric level at 1569 keV. The half-life of the isomer is determined as 200 ± 70 ns. This state is interpreted as a three-quasi-particle state with a probable spin of $21/2$. (8 figures, 6 tables) (auth)

4105 (p,t) REACTION ON EVEN ISOTOPES OF Sm. Debenham, Philip; Hintz, Norton M. (Univ. of Minnesota, Minneapolis). Nucl. Phys.; A195: No. 2, 385-414(1972).

The reactions ^{148,150,152,154}Sm(p,t) were studied at a bombarding energy of 19.00 MeV. Absolute differential (p,t) cross sections were measured with a split-pole magnetic spectrometer. Trends in the triton angular distribution shapes were identified for angular-momentum transfer, L, of 0, 2, and 3 units. On the basis of the angular-distribution shapes definite 0^+ and 3^- assignments and tentative 2^+ assignments were made. The (p,t) reaction is observed to populate excited 0^+ states in Sm with unusually high intensity, as does the (t,p) reaction. A qualitative explanation is given based on the model of Kumar and Baranger, in which the distinction between spherical and deformed nuclei is softened. In particular, 0^+ states at 1.255 MeV in ^{150}Sm and 1.426 MeV in ^{148}Sm, that are strongly excited by the (p,t) reaction, may be interpreted as "deformed" states in nuclei with "spherical" ground states. Rotational bands built on these 0^+ states are identified in the (p,t) spectra. These bands are seen to fit into the systematics of the Sm ground-state bands. (15 figures, 9 tables) (auth)

Nuclear Properties and Reactions, 190 ≤ A ≤ 219

Refer also to abstracts 2552, 4034, 4041, 4061, 4067, 4084, 4117, 4126, 4188, 4190, and 4193.

4106 (FRNC-TH-243) HELIUM JET COLLECTION OF ^{212}Fr, ^{213}Fr, AND ^{214}Fr PRODUCED BY REACTING HEAVY IONS WITH Tl AND Bi TARGETS. Sarda-Gugliermina, Martine (Paris Univ., Orsay (France)). 1972. 36p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The isotopes ^{212}Fr, ^{213}Fr, and ^{214}Fr produced by reacting ^{12}C (58 to 90 MeV) and ^{16}O (80 to 100 MeV) with Tl and Bi targets were studied using the helium jet technique. The excitation function of the ^{209}Bi(^{12}C,xn)$^{221-x}$Fr and the ^{205}Tl(^{12}C,xn)$^{217-x}$Fr reactions were traced. The role played by the 126 neutron magic shell on the probability of producing residual nuclei following the evaporation of some neutrons from the ^{221}Ac and ^{217}Fr compound nuclei was established. The measured fission cross section agrees with that obtained by Britt and Quinton for Bi. The cross section of Tl was found to be much smaller, thus demonstrating the fission stability of nuclei in the closed shell region. These results agree with theoretical values obtained for the fission cross section from neutronic width/fission width ratios calculated for isotopes following the de-excitation of ^{221}Ac and ^{217}Fr compound nuclei. (France)

4107 (FRNC-TH-272) FISSION OF INTERMEDIATE MASS NUCLEI INDUCED BY 126-MeV ^{14}N IONS. Cabot, Claude (Paris Univ., Orsay (France)). 1972. 112p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The fission induced by 126-MeV ^{14}N ions in medium-mass nuclei (^{27}Al, ^{40}Ca, ^{52}Cr, ^{58}Ni; ^{80}Se, Mo, ^{108}Ag, ^{165}Ho, and ^{197}Au) was studied. The detection of particles emitted in coincidence and the selection based on the difference in the time-of-flight enabled valid results to be obtained, taking into account the fission fragments only. Total fission cross sections of the order of a fraction of a millibarn were obtained. The variation in the fissionability with the Z^2/A parameter of the compound nucleus was studied. When Z^2/A values of less than 0.22 are considered, the uncertainty is about 50%. For higher values good agreement is found between the experimental values for the total fission kinetic energy and the theoretical values predicted by the liquid drop model. The mass distribution of the fragments is symmetric in the case of xenon, radon and tungsten. The theoretical values for the fissionability are smaller than the experimental values. (France)

4108 SOME PHOTON-INDUCED SPALLATION REACTIONS IN ^{209}Bi BY 1-GeV BREMSSTRAHLUNG. di Napoli, V.; Lacerenza, A. M.; Margadonna, D.; Terenzi, S. M. (Univ., Rome). Radiochem. Radioanal. Lett.; 11: No. 2, 99-104(25 Aug 1972).

Bi_2O_3 targets have been irradiated with 1-GeV bremsstrahlung beams and the cross sections per equivalent quantum of the photoproduction of some bismuth and gold isotopes have been measured by means of the induced activity and radiochemical methods. An upper limit of the cross section per equivalent quantum has also been evaluated for the production of ^{75}Se. (auth)

4109 GAMMA DECAY OF LOW-LYING STATES NEAR THE ^{208}Pb CLOSED SHELL. Haeeusser, O.; Khanna, F. C.; Ward, D. (Atomic Energy of Canada, Chalk River). Nucl. Phys.; A194: No. 1, 113-39(1972).

A number of electromagnetic matrix elements between low-lying states of several nuclei near ^{208}Pb have been measured. Coulomb excitation of states in ^{204,206,207,208}Pb and ^{209}Bi has been studied with beams of ^{4}He and ^{16}O. The energy loss of ^{4}He and ^{16}O in Pb has been measured by a novel method and thus accurate B(E2) and B(E3) values were obtained. Gamma-ray lineshapes observed after ^{16}O bombardment were used to derive mean lifetimes of states at 2646.5 keV ($\tau = 0.125 \pm 0.030$ ps) in ^{206}Pb, and at 897.7 keV ($\tau = 0.19 \pm 0.04$ ps), at 2624.4 keV ($\tau = 0.13 \pm 0.05$ ps), and at 2662.4 keV ($\tau = 0.95 \pm 0.20$ ps) in ^{207}Pb. The reactions ^{208}Pb-(^{7}Li,α2nγ)^{209}Bi and ^{208}Pb(^{7}Li,^{6}Liγ)^{209}Pb were used for the first time to derive several lifetimes and branching ratios in ^{209}Bi and ^{209}Pb. An intermediate-coupling calculation has been performed which reproduces extremely well the known B(E2) values in ^{207,208}Pb and ^{209}Bi and which qualitatively explains the observed E1 matrix elements. Evidence for retardation of single-particle M1 transitions is presented. The main cause for the retardation is excitations of spin-orbit partners. Possible contributions from higher-order excitations and from mesonic exchange currents are discussed. (auth)

4110 NEW HIGH-SPIN ISOMER 2.3-DAY ^{198m}Au AND THE ^{198}Au LEVEL STRUCTURE. Cunnane, J. C.; Daly, P. J. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C.; 6: No. 4, 1407-11(Oct 1972).

In 18-MeV deuteron bombardments of enriched ^{200}Hg, a new isomer, (2.27 ± 0.05)-day ^{198m}Au, which is believed to be analogous to the $(h_{9/2}\pi, i_{13/2}\nu)12^-$ isomer in ^{196}Au was produced. No β^- branching was observed in the decay of ^{198m}Au. The isomeric transition is followed by a cascade of 204.10- and 180.31-keV γ rays to a 123-ns level at 312.10 keV, which de-excites to ground by a sequence of 97.21-keV (E1) and 214.89-keV (E2) transitions. A revised interpretation of the results of earlier (n,γ) and (d,pγ) studies of

the ^{198}Au level structure is presented, and shell-model assignments for the levels populated in the isomeric decay are proposed. It is argued that the E1 deexcitation of the 123-ns isomer involves the l-forbidden single-particle transition $(d_{\frac{3}{2}}\pi, i_{\frac{13}{2}}\nu)5^+ \rightarrow (d_{\frac{3}{2}}\pi, f_{\frac{5}{2}}\nu)4^-$. (3 figures, 1 table). (auth)

4111 LEVELS IN ^{205}Pb POPULATED BY THE DECAY OF ^{205}Bi. Hamilton, J. H. (Vanderbilt Univ., Nashville); Ananthakrishnan, V.; Ramayya, A. V.; (and others). Phys. Rev., C.; 6: No. 4, 1265-80(Oct 1972).

Chemically and isotopically separated sources of ^{205}Bi were used to study the level structure of ^{205}Pb. γ-ray data were taken with Ge(Li) detectors in the singles mode, with a Compton suppression spectrometer, and with a Ge(Li)–Ge(Li) two-parameter analyzer system in a 4096 × 2048 coincidence mode. Conversion-electron data were taken with a Si(Li) detector. From these data 146 transitions were identified in the decay of ^{205}Bi, and 130 were placed in a level scheme which included 26 definite and 1 tentatively assigned levels. Previously suggested levels at 1575.26, 1705.03, 1965.9, and 2521.40 keV were confirmed from coincidence data, while a 1129.9-keV level was not. New levels at 1756.4 and 1842.01 were established, and an 1818-keV level was tentatively assigned. Several new spin and parity assignments are made. Experimental results are compared with recent shell-model calculations. (auth)

4112 ELECTRON-CAPTURE-TO-POSITRON RATIO IN ^{207}Bi DECAY. Rupnik, Tomaz (Univ. of Oregon, Eugene). Phys. Rev., C.; 6: No. 4, 1433-5(Oct 1972).

Positron emission in the second-forbidden nonunique transition from the ground state of ^{207}Bi to the first excited level of ^{207}Pb was found to occur in $(1.2 \pm 0.2) \times 10^{-4}$ of all decays. After taking into account newly assigned relative intensities of the ^{207}Bi electron-capture decay branches, the EC/β^+ ratio is found to be $(6 \pm 1) \times 10^2$. From the β^+ intensity and the measured ^{207}Bi half-life of 38 ± 4 yr, it follows that log ft = 12.6 ± 0.1 for this transition. (2 figures) (auth)

4113 ^{208}Pb$(\gamma,n)^{207}$Pb AND THE GIANT M1 RESONANCE. Toohey, R. E.; Jackson, H. E. (Argonne National Lab., Ill.). Phys. Rev., C.; 6: No. 4, 1440-3(Oct 1972).

Photoneutron resonances and their angular distributions were studied in a high-resolution measurement of the ^{208}Pb$(\gamma,n)^{207}$Pb reaction near threshold. The angular distributions observed for lower-energy photoneutron resonances tend to confirm the conclusions of earlier experiments, which suggest the existence of a giant M1 resonance in ^{208}Pb. (2 figures, 1 table) (auth)

4114 STUDY OF $(\alpha,\alpha n)$ REACTIONS WITH 900-MeV HELIUM IONS. Church, L. B. (State Univ. of New York, Buffalo). Phys. Rev., C.; 6: No. 4, 1293-7(Oct 1972).

Cross sections for $(\alpha,\alpha n)$ reactions with ^{58}Ni, ^{65}Cu, and ^{197}Au at 900 MeV were determined relative to the ^{27}Al$(\alpha,\alpha 2pn)^{24}$Na monitor reaction. They are 49.3 ± 3.5, 64.6 ± 2.8, and 95.8 ± 1.4 mb, respectively. The cross section used for the monitor reaction at this energy was 22.0 mb; this was determined through a comparison of the ^{24}Na and ^{18}F activities produced in Al foil by 920-MeV helium ions. The general trends observed in $(\alpha,\alpha n)$ cross sections as a function of target composition are discussed. The ratio of direct population of the (12^-) to (2^-) states of ^{196}Au is 0.07, and this suggests a mechanism of direct emission of the neutron from the target surface. The observed trend of $\sigma(\alpha,\alpha n)$ with the neutron skin thickness of the target also supports this mechanism. These reactions are compared with the high-energy (p,pn) reactions of the same targets. (4 figures, 2 tables) (auth)

4115 MAGNETIC DIPOLE TRANSITIONS IN THE VICINITY OF ^{208}Pb. Arima, A.; Huang-Lin, L. J. (State Univ. of New York, Stony Brook). Phys. Lett.; 41B: No. 4, 429-34(16 Oct 1972).

Magnetic dipole transition rates are calculated in the vicinity of ^{208}Pb. The effects of core polarization and mesonic exchange currents, which seem to be the two main mechanisms to renormalize the nuclear M1 operator, are taken into account. The calculated rates are in impressive agreement with the recent measurements made by the Chalk River Group. The effect of exchange currents competes with that of core polarization in l-forbidden M1 transitions, but the former is negligible in allowed M1 transitions. The reason for this is clarified. (auth)

4116 THREE-PHONON MONOPOLE AND QUADRUPOLE PAIRING VIBRATIONAL STATES IN ^{206}Pb. Flynn, E. R. (Los Alamos Scientific Lab., N. Mex.); Igo, G. J.; Broglia, R. A. Phys. Lett.; 41B: No. 4, 397-402(16 Oct 1972).

Levels with $J^\pi = 0^+$ and 2^+ were observed in the ^{204}Pb(t,p)^{206}Pb reaction near 6 MeV in excitation energy with cross sections, Q-values, and angular distributions in accordance with the pairing–vibrational-model prediction. From the experimental data it is concluded that these states have a 4-hole–2-particle character, containing appreciable amplitudes of monopole and quadrupole pairing vibrations. (auth)

4117 RATIO OF PION–NUCLEUS REACTION CROSS SECTIONS AND THE NEUTRON DENSITY DISTRIBUTION FOR LEAD. Allardyce, B. W. (Rutherford High Energy Lab., Chilton, Eng.); Batty, C. J.; Baugh, D. J.; (and others). Phys. Lett.; 41B: No. 5, 577-80(30 Oct 1972).

The ratio of the reaction cross sections for π^- and π^+ mesons was measured for a series of nuclei over the momentum range from 0.71 to 2.0 GeV/c. An analysis of the results for C and Pb is presented and compared with the predictions of a variety of nuclear models. (auth)

4118 TIME DIFFERENTIAL g-FACTOR MEASUREMENT OF THE 7^+ ISOMER IN ^{204}Tl. Maier, K. H. (Univ. of California, Berkeley). Nucl. Phys.; A195: No. 2, 577-80(1972).

The g factor of the 1.118-MeV 7^+ level in ^{204}Tl ($T_{\frac{1}{2}} = 63$ μs) was measured as g = +0.1696 ± 0.0010 n.m. by time-differential observation of the perturbed angular distribution of the de-exciting γ rays. The isomer was excited by a pulsed deuteron beam through the ^{204}Hg(d,2n)^{204}Tl reaction. The meaning of the result for the structure of the level is discussed. (1 figure, 1 table) (auth)

4119 NOTE ON THE DECAY OF ^{200}Au. Helppi, H.; Pakkanen, A. (Univ. of Jyvaeskylae, Finland). Z. Phys.; 255: No. 5, 385-9(1972).

Gamma and beta rays from the decay of ^{200}Au (48.4 min) were studied employing Ge(Li) and plastic detectors in various singles and coincidence arrangements. The intensity of the β-branch to the ground state of ^{200}Hg was determined as 79%, and the disintegration energy of ^{200}Au to be as $Q_\beta = 2.26 \pm 0.06$ MeV. A tentative spin and parity assignment of $(1,2)^+$ is proposed for levels at 1515.2 and 1972.5 keV in ^{200}Hg. (auth)

Nuclear Properties and Reactions, A ≥ 220

Refer also to abstracts 2552, 4048, 4054, 4097, 4192, 4199, and 4205.

4120 (IAEA-R-611-F) MEASUREMENTS ON DELAYED NEUTRONS FROM FAST FISSION. Final Report for the Period April 1, 1968–April 30, 1971. Shalev, S. (International Atomic Energy Agency, Vienna (Austria)). Oct 1971. 51p. INIS.

The energy spectra of delayed neutrons were measured for thermal fission of ^{233}U, ^{235}U, and ^{239}Pu and for fast fission of ^{232}Th and ^{238}U. (auth)

4121 NEW DATA ON ALPHA DECAY OF ^{253}Es AND THE ENERGY LEVELS OF THE ^{249}Bk AND ^{250}Bk NUCLEI. Baranov, S. A.; Shatinskii, V. M.; Kulakov, V. M.; Rodionov, Yu. F. (Inst. of Atomic Energy, Moscow). Zh. Eksp. Teor. Fiz.; 63: No. 2, 375-84(Aug 1972). (In Russian).

The energy states of ^{249}Bk arising in alpha decay of ^{253}Es are studied by means of the technique of deviation of charged particles in a magnetic field. More than forty α groups with α particle energies ranging from 5630 to 6650 keV are detected in the α spectrum of ^{253}Es. Some of the ^{249}Bk excited states are interpreted from the viewpoint of the unified nuclear model. It is pointed out that in the ^{249}Bk level scheme there are at least five bands with the quantum characteristics $\frac{7}{2}^+[533\uparrow]$, $\frac{3}{2}^-[521\uparrow]$, $\frac{5}{2}^+[642\uparrow]$, $\frac{5}{2}^-[523\downarrow](?)$, $\frac{7}{2}^-[514\downarrow](?)$. Alpha decay of the odd-odd ^{254}Es nucleus is also investigated. In the spectrum of the daughter nucleus ^{250}Bk the existence of four bands is established which possess the following $J\pi K$ quantum characteristics: 2^-2, 4^+4, 7^+7 and 5^-5. (auth)

4122 SEARCH FOR SPONTANEOUSLY FISSIONING ISOMERS PRODUCED WITH 600 MeV PROTONS. Boos, A. H.; Brandt, R.; Molzahn, D.; Montgomery, D. M. (Univ., Marburg, Ger.). J. Inorg. Nucl. Chem.; 34: No. 11, 3309-17(Nov 1972).

Spontaneously fissioning isomers could not be detected in the interaction of uranium, thorium, bismuth, and lead with 600 MeV protons. Upper limits for their formation cross section $\sigma_{II}^{\dagger}$ were evaluated; for short-lived isomers in the region mercury to thorium: $\sigma_{II}^{\dagger} \leq 10^{-30}$ cm^2, for long-lived isomers in the actinide region: $\sigma_{II}^{\dagger} \leq 10^{-31}$ to 10^{-34} cm^2. (auth)

4123 REACTION-SPECTROSCOPY STUDIES OF THE ACTINIDE ELEMENTS. III. LEVELS IN ^{241}Pu AND ^{243}Pu. Braid, T. H.; Chasman, R. R.; Erskine, J. R.; Friedman, A. M. (Argonne National Lab., Ill.). Phys. Rev., C.; 6: No. 4, 1374-84(Oct 1972).

Properties of levels in ^{241}Pu and ^{243}Pu were determined by (d,p) and (d,t) reactions on targets of ^{240}Pu and ^{242}Pu. The reactions

$^{240}Pu(n,\gamma)^{241}Pu$ and $^{241}Pu(d,d')^{241}Pu$ were also studied. On the basis of these data, single-particle assignments are made for levels in ^{241}Pu and ^{243}Pu. Single-particle spectra, extracted from the data by means of a pairing-force calculation, are compared both with those of the isotonic nuclides and with the single-particle spectra calculated from a deformed Woods–Saxon potential. (9 figures, 4 tables). (auth)

4124 $^{238}U(n,\gamma)^{239}U$ AND STATES OF ^{239}U. Bollinger, L. M.; Thomas, G. E. (Argonne National Lab., Ill.). Phys. Rev., C.; 6: No. 4, 1322-38(Oct 1972).

The high-energy regions of the γ-ray spectra formed by thermal-neutron capture and by average resonance capture were measured with an annihilation-pair Ge(Li) spectrometer. The observed γ-ray lines reveal the presence of many new states in ^{239}U, and the intensities of lines in the average resonance-capture spectra establish the parities and limit the spins of the states. The data are entirely consistent with what is expected from the set of single-particle configurations used by Braid et al. to interpret the states of four odd-A curium isotopes; i.e., all states with excitation energies less than 890 keV are interpretable in terms of these configurations, and no unobserved states are predicted. The average widths of E1, M1, and E2 transitions are compared with the results of other experiments and with theory. The average E1 and M1 widths are consistent with what is expected, but the average E2 width is unusually large. The unusual strength of one E1 transition is discussed. The relationship between the branching ratios for thermal-neutron capture and for resonance capture is discussed. (8 figures, 3 tables). (auth)

4125 DECAY OF ^{232}Np. Weiss-Reuter, R.; Muenzel, H.; Pfennig, G. (Kernforschungszentrum, Karlsruhe, Ger.). Phys. Rev., C.; 6: No. 4, 1425-9(Oct 1972).

The decay of $^{232}_{93}Np$ was studied by γ spectroscopy with a Ge(Li) spectrometer. The energies and relative intensities of 24 γ peaks were determined. A decay scheme with two new energy levels at 1098.2 and 1146.3 keV is proposed. The level at 1193.9 keV was confirmed. Electron-capture branching intensities are given. (2 figures, 5 tables). (auth)

4126 RECOIL PROPERTIES OF RARE-EARTH NUCLIDES PRODUCED BY THE INTERACTION OF 28-GeV PROTONS WITH URANIUM AND GOLD. Cumming, J. B.; Baechmann, K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C.; 6: No. 4, 1362-72(Oct 1972).

The thick-target–thick-catcher technique was used to determine the recoil properties of some rare earth nuclides produced by the interaction of 28-GeV protons with uranium and gold. Mean momenta derived from this and other experiments are discussed in terms of fission and spallationlike processes. It is concluded that, while fission can account for neutron-rich products from uranium, the momenta of neutron-deficient rare earth nuclides from both uranium and gold are too low to arise from any conventional fission process. In the mass region below the rare earths, many neutron-deficient isotopes appear to be formed by mixed mechanisms. Only the most neutron-deficient products have momenta as low as those predicted for a spallationlike process. Mean cascade deposition energies, E*, derived from the forward-to-backward ratios average 145 MeV for the neutron-deficient rare earths from uranium and 199 MeV for these products from gold. Such low values for gold and the even lower values for uranium cannot be understood in terms of a model for the spallationlike process involving a nucleonic cascade followed by conventional evaporation. Either there is a breakdown of the two-step model, as might be expected if fragment emission is involved, for instance, or it is not valid to extrapolate to 28 GeV the momentum-transfer–excitation-energy relationship inferred from Monte Carlo calculations at much lower energies. (8 figures, 4 tables). (auth)

4127 ABSOLUTE MEASUREMENT OF THE ENERGY OF α PARTICLES EMITTED BY ^{232}U AND ^{240}Pu. Gorman, D. J.; Rytz, A.; Michel, H. V. (Bureau International des Poids et Mesures, Sevres, France). Compt. Rend., Ser. B; 275: No. 8, 291-4 (21 Aug 1972). (In French).

An absolute spectrograph of the International Bureau of Weights and Measures was used to measure the energy of the α_0 and α_{58} lines of ^{232}U and the α_0 and α_{45} lines of ^{240}Pu. The results are in good agreement with previous results (which have been recalibrated) but are very much more accurate. (France)

4128 EVOLUTION OF THE DISTRIBUTION OF Cs ISOTOPES PRODUCED IN THE FISSION OF ^{238}U BY INTERMEDIATE ENERGY ALPHA PARTICLES. Favard, J. P. (Bordeaux Univ., Gradignan, France); Fleury, A.; Hamon, F.; Simonoff, G. N.; Nguyen-Long-Den. J. Phys. (Paris); 33: No. 5, 473-6 (May 1972). (In French).

The production cross sections for $^{132,134,136,137}Cs$ isotopes produced by interactions between 25- to 120-MeV α particles and ^{238}U targets were measured. The results obtained are in good agreement with the unchanged charge distribution hypothesis. The distribution widths initially remain constant and then increase by two mass units between 60 and 90 MeV. The energy required to induce one or other of the fragments to evaporate an additional neutron was estimated to be 10 MeV, this estimation being made from considerations of the fission evaporation competition. (France)

4129 RADIATIVE CAPTURE OF NEUTRONS BY ^{238}U IN THE ENERGY RANGE 5.0 TO 20.0 MeV. Panitkin, Yu. G.; Tolstikov, V. A. At. Energ. (USSR); 33: No. 4, 825-7(Oct 1972). (In Russian).

The cross section of radiative capture of neutrons by ^{238}U in the energy range 5.0 to 20.0 MeV was measured. The measurements were performed by the activation method on an electrostatic accelerator. Induced activity was determined by means of a Ge(Li) detector on the basis of γ quanta produced during ^{239}U decay. An ionization fission chamber having a ^{235}U layer and the reaction $^{27}Al(n,p)^{27}Mg$ served as monitors of the neutron flux. (auth)

Nuclear Theory

Refer also to abstracts 3676, 3762, 3773, 4026, 4060, 4081, and 4083.

4130 (AERE-R-7207) LIBRARY OF NEUTRON INDUCED FISSION PRODUCT YIELDS MAINTAINED AND INTERROGATED BY COMPUTER METHODS. PART II. THE INTERROGATION OF THE LIBRARY. Crouch, E. A. C. (Atomic Energy Research Establishment, Harwell (England)). Aug 1972. 2p. Dep. NTIS (U. S. Sales Only). UK 50 pence.

The second step towards objective assessment of fission product yields is reported, being the setting up of a computer program to interrogate the computer based library of Fission Product Yields. The output of the program is dependent on the type of information required. (auth)

4131 (BNL-17023) NONSTATISTICAL EFFECTS IN RADIATIVE NEUTRON CAPTURE. Mughabghab, Said F. (Brookhaven National Lab., Upton, N. Y.). 1972. 28p. (CONF-720701-5). Dep. NTIS.

From International conference on nuclear structure study with neutrons; Budapest, Hungary (31 Jul 1972).

Nonstatistical aspects of the reaction mechanism of radiative neutron capture in the 3S, 3P, and 4S giant resonances are examined. It is shown that (d,p) and (n,γ) correlations observed in thermal capture in the 3S giant resonance region may be interpreted in terms of valence neutron capture. In the 3P giant resonance, valence neutron capture dominates in nuclei such as ^{98}Mo, ^{96}Zr, ^{108}Pd. The correlations observed in $^{173}Yb(n,\gamma)^{174}Yb$ are accounted for in terms of a doorway state. Examples are cited where nonstatistical effects are correlated with a concentration of S- or P-wave neutron strength. (auth)

4132 (CONF-720933-2) RENORMALIZED BRUECKNER–HARTREE–FOCK APPROXIMATION. Becker, Richard L. (Oak Ridge National Lab., Tenn.). 1971. 45p. Dep. NTIS.

From Symposium on present status and novel developments in the nuclear many-body problem; Rome, Italy (Sep 1972).

The renormalization of many-body perturbation theory by factorization of insertions in single-particle (SP) lines having the significance of "true" occupation probabilities is reviewed. The renormalized Brueckner–Hartree–Fock (RBHF) approximation is defined, and its analog of Koopmans' theorem on the near equality of separation energy centroids and SP energies is demonstrated. The plane wave and harmonic oscillator bases of SP states, and the energy spectrum of the virtual, excited, SP states are discussed. Binding energies, charge densities, and SP energies of light, spherical nuclei obtained with RBHF calculations in the oscillator basis are presented. Corrections to the RBHF approximation, associated with correlations and rearrangement, are considered. Configuration mixing leads to a distribution of SP strength over many eigenstates. Values are given for the second order rearrangement energy, the main contribution to the shift away from the centroid of the eigenstate of greatest SP strength. For deep holes the strength function broadens as 2h-1p states, etc. become quasi-degenerate with 1h states; as an example, the $(Os)^{-1}$ strength function in ^{16}O is shown. Correlation corrections to the RBHF charge density are discussed. Results of RBHF calculations for nuclei with a neutron excess are cited, and prospects of future improvements in calculations employing the RBHF approximation are contemplated. (auth)

4133 (COO-3001-19) WHAT MAGNETIC MOMENTS TELL US ABOUT NUCLEAR FORCES AND NUCLEAR STRUCTURE. Brown, G. E. (Nordisk Institut for Teoretisk Atomfysik, Copen-

hagen (Denmark). State Univ. of New York, Stony Brook). 1972. Contract AT(11-1)-3001. 15p. (CONF-720932-2). Dep. NTIS.

From International conference on nuclear structure; Osaka, Japan (4 Sep 1972).

The empirical procedures used in the description of nuclear magnetic moments are reviewed. Properties of nuclear structure and nuclear forces which may be understood only by a more basic theory are discussed. Some fundamental questions are posed which can be answered only by a basic theory. (J.W.R.)

4134 (COO-3001-22) MODIFICATION OF HAUSER-FESHBACH CALCULATIONS BY DIRECT-REACTION CHANNEL COUPLING. Kawai, Mitsuji (State Univ. of New York, Stony Brook. Dept. of Physics); Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge. Dept. of Physics); McVoy, K. W. (Los Alamos Scientific Lab., N. Mex. Indiana Univ., Bloomington. Dept. of Physics). 1972. 23p. Dep. NTIS.

If open channels are strongly coupled by direct reactions, the traditional Hauser-Feshbach method of calculating fluctuation cross sections is invalid, because of non-statistical correlations which the direct channel-coupling induces between resonance partial widths in different channels. The fluctuation cross sections can still be computed from the optical S-matrix elements, however, and the formulas necessary for doing so are obtained here with the aid of an "optical background" representation of the full S-matrix. The resulting compound-elastic cross section is increased over the Hauser-Feshbach expression by a factor of $2(\Gamma \gg D)$ or $3(\Gamma \ll D)$ in the large-N limit, and compound-reaction cross sections are increased by roughly a factor of $(N + 1)/N$, where N is the number of directly-coupled open channels. (auth)

4135 (COO-3235-15) VALIDITY OF DWBA IN A THREE-BODY MODEL OF STRIPPING. Bouldin, D. P.; Levin, F. S. (Brown Univ., Providence, R. I. Dept. of Physics). 1972. 4p. (CONF-720819-13). Dep. NTIS.

From International conference on few particle problems in nuclear interactions; Los Angeles, CA. (28 Aug 1972).

Calculations were made to test the hypothesis that the deuteron elastic scattering wave function used in deriving DWBA stripping amplitudes and the spectator function F are approximately equal. It was found that these two functions are not equal. This implies that although the DWBA model produces reasonable angular distributions it does not provide good agreement in detail. (J.W.R.)

4136 (COO-3235-16) DOORWAY STATES AND INELASTIC ELECTRON SCATTERING. Fallieros, S. (Brown Univ., Providence, R. I. Dept. of Physics). 1972. 12p. (CONF-720907-3). Dep. NTIS.

From International conference on nuclear structure studies using electron scattering and photoreaction; Sendai, Japan (12 Sep 1972).

A discussion of some simple properties of transition densities as they appear in inelastic electron scattering experiments is given. The concept of doorway states is introduced and described, and the nature of their participation in the excitation process is given. Sum rules are derived that impose limitations on the properties of these states, and it is shown how approximations on the number of participating doorways can lead to simple predictions which can be compared with experimental results. (L.T.W.)

4137 (FRNC-TH-267) E_2 AND E_0 ELECTROMAGNETIC PROPERTIES OF 0^+ STATES EXCITED IN EVEN NUCLEI IN THE RARE EARTH REGION. Silvestre-Brac, Bernard (Universite Scientifique et Medicale de Grenoble (France)). 1972. 72p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The RPA (random phase approximation) method is used to study the E_2 and E_0 electromagnetic properties of 0^+ excited states in even nuclei in the rare earth region. The choice of Hamiltonian and the different types of state obtained (with collective vibrations, even vibrations or two quasi-particle states) are discussed. The E_2 and E_0 interband transitions are calculated. The results obtained are compared with the exact matrix elements of Boisson-Piepenbring and those of Nilsson. The effect of various numerical factors (deformation, gaps, and cut-off) on the results of the calculations are investigated. (France)

4138 (FRNC-TH-271) NUCLEAR SPECTROSCOPY OF THE $1f_{\frac{7}{2}}$ SHELL. Brut, F. (Grenoble Univ. (France)). 1972. 112p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The nuclear shell model in which the nucleons outside the core remain in the $1f_{\frac{7}{2}}$ shell was used to study the spectra of the levels of nuclei having masses between 42 and 48, various residual interactions being considered. Some of the results are in quite good agreement with the experimental results. Thus, the presence of the 2^+-6^+ weakly excited doublet in the spectra of the cross conjugate $^{44}Sc-^{52}Mn$ pair was well reproduced by several interactions. These interactions also enabled the $5/2^- - 7/2^-$ doublet of the $^{45}Ti-^{51}Mn$ pair to be obtained together with the 4^+, 6^+, 3^+, and 5^+ states of $^{46}Sc-^{50}V$, the $5/2^- - 7/2^-$ doublet of $^{47}Ti-^{49}V$, and the $J^\pi = 4^+$ ground state level of ^{48}V. The rotational spectrum of ^{48}Cr was also studied. (France)

4139 (HMI-B-125) FOUR-PARTICLE CORRELATIONS IN NUCLEI. Lectures Given at the Fifth Summer School in Nuclear Physics, Rudziska, Poland, 1972. Eichler, Joerg (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Sep 1972. 61p. Dep. NTIS (U. S. Sales Only).

The theoretical and experimental evidence for four-body correlations is reviewed. Topics discussed include alpha clusters, the relation between cluster structure and shell structure, quartet structure, the quadruple model, and experimental evidence. (J.W.R.)

4140 (ITF-72-76-P) SOME EFFECTS OF NUCLEAR ELECTROSPLITTING CONNECTED WITH THE DISTORTION OF THE NUCLEON WAVE FUNCTIONS AND THEIR BEHAVIOR OFF A NUCLEUS. Tartakovskii, V. K.; Malyarzh, E. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The process of light nuclei electrosplitting accompanied by the nucleons being knocked out from definite nuclear shells is considered. A contribution of the external and internal parts of the bound-state nucleon wave functions to the deformed and undeformed nucleon momenta distributions in nuclear shells is investigated. The polarizations of nucleons knocked out from various shells are calculated. (auth)

4141 (JINR-P2-6583) CHARGE PION PHOTOPRODUCTION AND THE VECTOR DOMINANCE MODEL VIOLATION. Gevorkyan, S. R.; Tarasov, A. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1972. 8p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that violation of the vector dominance model, observed in the experiment with nucleons, allows the charged pion photoproduction on nuclei to be explained within the framework of the noncoherent production. (auth)

4142 (JINR-P4-6625) ANGULAR DISTRIBUTION OF THE SPONTANEOUSLY FISSIONING ISOMER FRAGMENTS. Pham Zui Hien (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

The problem is considered of the angular distribution of the spontaneously fissioning isomer fragments produced in the reactions with charged particles bringing in large angular momentum to the nucleus. The problem is reduced to the study of the influence of the emission of particles and gamma-quanta, after the compound nucleus production, on the isomer spin orientation. The effect of the extranuclear perturbations on the fragment angular distribution is also considered. The possibility is discussed of determination of the isomer state characteristics using the experimental data on the fragment angular distribution. (auth)

4143 (JINR-P7-6619) ENERGY DEPENDENCE OF THE RATIO Γ_n/Γ_f IN THE RANGE OF TRANSURANIUM ELEMENTS. Barashenkov, V. S.; Gereghi, F. G.; Iljinov, A. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1972. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that contrary to widespread opinion, the ratio of fission-evaporation widths Γ_n/Γ_f for transuranium elements may depend essentially on the excitation energy. As a rule, some other value rather than ratio Γ_n/Γ_f is measured experimentally. This value turns out to be practically independent of the energy both in theory and in experiment. (auth)

4144 (JINR-P16-6623) FLUXES OF NEUTRONS GENERATED BY HIGH-ENERGY PROTONS IN THE THICK BLOCKS OF URANIUM. Barashenkov, V. S.; Toneev, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1972. 20p. (In Russian). Dep. NTIS (U. S. Sales Only).

Multiplication of particles in big uranium blocks, bombarded by protons with the energy T = 300-700 MeV, is considered using the Monte-Carlo method. In a block of ^{238}U, on the average about 65 neutrons are produced per one primary proton energy of $T \cong 700$ MeV. Use of the natural mixture of uranium isotopes (0.72% ^{235}U) increases the yield of neutrons by nearly a quarter. The yield of neutrons can be increased due to homogeneous admixture of light elements on the ionization path length in uranium. Data on the heat release in the block are presented as well as some conclusions on the neutron multiplication by a high-energy deuteron beam. (auth)

4145 (JUL-841-KP) ORBITAL REARRANGEMENT IN LIGHT NUCLEI. Muether, H. (Kernforschungsanlage, Juelich

(West Germany). Institut fuer Kernphysik). Apr 1972. 51p. (In German). Dep. NTIS (U. S. Sales Only).

The orbital rearrangement energies in the Hartree–Fock model lie in the order of magnitude of 1 MeV for a pickup from the 1_s-shell and 0.2 MeV from the 1_p-shell, respectively. Thus, the energies appear nearly negligible. Studies of the quadrupole momentum, however, show that the shape of the nucleus changes more definitely than can be expected from the rearrangement energies. Thus it is possible that, in a Brueckner–Hartree–Fock computation, the orbital rearrangement becomes strongly noticeable through the BG equation. Studies of the effect of orbital rearrangement on density distribution and quadrupole momentum show that changes in the shape of the nucleus during a pickup are strengthened through changes of the wave function. (tr-auth)

4146 (JUL-843-KP) INFLUENCE OF TWO-BODY SPIN-ORBIT INTERACTION IN INELASTIC NUCLEON SCATTERING IN THE FRAME OF A DISTORTED WAVE BORN APPROXIMATION. Sprickmann, Rainer (Kernforschungsanlage, Juelich (West Germany). Institut fuer Kernphysik). Apr 1972. 103p. (In German). Dep. NTIS (U. S. Sales Only).

Calculations on ^{90}Zr and ^{16}O showed that the microscopic antisymmetric distorted wave Born approximation reproduces well the analyzed reactions. The non-normal parity transition in ^{16}O is explained excellently. Agreement between theory and experiment is not quite as good for the inelastic processes on ^{90}Zr. The discrepancies can be improved if the bound states are described by a Saxon-Woods wave function with nonlocality correction. Moreover, an improved optical potential is required for the exit channel of the 18.8 MeV reaction. Such calculations are planned. In spite of the above mentioned disadvantages, the present calculations clearly demonstrate the significance of a spin-orbit term. (tr-auth)

4147 (JUL-844-KP) CALCULATION OF THE DEFORMATION ENERGY SURFACE FOR NUCLEAR FISSION AND ASYMMETRY IN THE FRAGMENT MASS DISTRIBUTION. Slavov, B. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Kernphysik). Apr 1972. 145p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Muenster Univ., Ger.

An attempt has been made to explain the fission process in heavy nuclei. A new method is proposed to calculate the deformation energy from a single particle potential which is correct in light of the constrained Hartree–Fock (CHF) theory. As another possibility, a shell correction method has been investigated. It is analytically shown that the expression for the deformation energy at local extremum obtained in the shell correction method is identical to the expression of the CHF energy up to first order in the density fluctuation. Here the density fluctuation is defined as the difference between the shell model single particle level density and the averaged (smeared out) single particle level density. At all other points the expression of the CHF energy has an additional term $\lambda (Q-\tilde{Q})$, where Q and $\tilde{Q}$ are the expectation value of the considered multipole moment calculated with the shell model density and the averaged density respectively. The asymmetry of the fragment mass distribution of the fissioning nuclei is by suitable parametrization of an asymmetric two center potential, and a good agreement with experiment was obtained. The total energy of the asymmetric two center potential was renormalized by applying the shell correction prescription of Strutinsky. A new prescription to make a correspondence between a liquid drop and the shape of a potential is proposed which assumes the equivalence of several essential multipole moments. It is shown that the asymmetric two center shell model is specially suited for the description of the scission asymmetry which turns out to be strongly dependent on the shell structure of the fragments. This property of the asymmetric two center shell model is not sensitive to a renormalization of the potential energy surface due to Strutinsky shell correction. (auth)

4148 (JUL-852-KP) POLARIZATION OF ALPHA CLUSTERS. Gruemmer, F. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Kernphysik). May 1972. 42p. (In German). Dep. NTIS (U. S. Sales Only).

Calculations initially were performed without taking into consideration the degree of freedom of polarization. Calculated were the ground-level parameter, the ground-level energy, and the probability values of the 4N-nuclei from ^{8}Be to ^{20}Ne. Results were tabulated. Based on these ground-level parameters, calculations were then performed which took polarization into consideration. Results showed that cluster deformation in the alpha-cluster model plays an important role. (H.B.G.)

4149 (LA-4777) ANGULAR DISTRIBUTIONS AND CORRELATIONS OF RADIATIONS EMITTED FROM ORIENTED NUCLEI. III. DIRECTIONAL CORRELATIONS OF TWO RADIATIONS EMITTED FROM ORIENTED NUCLEI AND TRIPLE DIRECTIONAL CORRELATIONS. Krane, K. S.; Steffen, R. M. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 70p. Dep. NTIS.

A convenient and generally applicable formulation of the directional correlation of two successive nuclear radiations emitted from an initial oriented nuclear state and of triple directional correlations is presented. The pertinent generalized directional-distribution coefficients are expressed in terms of generalized F-coefficients. Extensive numerical tables of these coefficients are given. For normal and parallel geometries, the directional correlation of radiations from oriented states or the triple directional correlation can be expressed in terms of the ordinary Legendre polynomials; i.e., $W(\theta) = \Sigma_\Lambda \Gamma_\Lambda P_\Lambda (\cos\theta)$. Graphs of the distribution parameters Γ_Λ as a function of the explicitly defined gamma multipole mixing ratios δ are presented, and some special cases are discussed in detail. (auth)

4150 (LA-5052) PAULI PRINCIPLE AND PION SCATTERING. Bethe, H. A. (Los Alamos Scientific Lab., N. Mex.). Oct 1972. Contract W-7405-eng-36. 4p. Dep. NTIS.

It is pointed out that if the Pauli principle is taken into account in the discussion of pion scattering by complex nuclei (as it ought, of course, to be) some rather implausible consequences of some earlier treatments of this problem can be avoided. (auth)

4151 (LBL-1225) E2 STATIC MOMENTS AND E2, E4 TRANSITION MOMENTS BY COULOMB EXCITATION. Diamond, R. M. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 41p. (CONF-720932-3). Dep. NTIS.

From International conference on nuclear moments and nuclear structure; Osaka, Japan (4 Sep 1972).

Coulomb excitation, when done at low enough bombarding energies so that nuclear interactions do not interfere, is a useful method for determining nuclear electric moments. With heavy ions, multiple excitation processes predominate, allowing the determination of the moments of more states; but so many levels may be involved, that the calculations become quite complicated. Since a semi-classical theory is usually employed, quantal corrections must also be considered. Nevertheless, accuracy of a few percent in B(E2) values can be obtained. Static quadrupole moments for the first 2^+ state in many even–even nuclei have been measured, although some ambiguities remain. Recently a number of E4 moments have been determined, and they appear to be quite large, ~100 B(E4) sp. (auth)

4152 (LBL-1251) CORIOLIS EFFECTS IN NUCLEI. Stephens, F. S. (California Univ., Berkeley. Lawrence Berkeley Lab.). Sep 1972. Contract W-7405-eng-48. 85p. Dep. NTIS.

After a brief introduction chapters are included on Coriolis effects as perturbations in rotational spectra, Coriolis effects in nuclei with small deformations, and Coriolis effects in even–even nuclei. (27 references) (J.W.R.)

4153 (NP-19463) SOME NEW ASPECTS IN THE COULOMB BREAK-UP OF NUCLEI. Report No. 30. Hansteen, J. M.; Wittern, H. W. (Bergen Univ. (Norway). Dept. of Physics). Oct 1970. 30p. Dep. NTIS (U. S. Sales Only).

Current ideas on Coulomb break-up processes of accelerated heavy ions are critically analyzed in the light of recent experimental findings. Suggestions and predictions for further experiments are put forward, aimed at testing the region of validity of the theory of pure Coulomb disintegration. The importance of such investigations is stressed for the partial understanding of collisions between nucleon complexes. (Norway)

4154 DE-EXCITATION OF p-LEVELS OF EVEN–ODD NUCLEUS WITH $21 \leq A \leq 41$ AFTER THERMAL NEUTRON CAPTURE. Demidov, A. M.; Dkzafar, Dzh. D.; Khalil, M. A.; Khussein, F. A. (Inst. of Atomic Energy, Moscow). Yadern, Fiz.; 16: No. 1, 3-11(Jul 1972). (In Russian).

The most of even–odd nucleus p-levels for $21 \leq A \leq 41$ which have a large neutron width have been found to be characterized by a greatest reduced probability I_ν/E_γ^3 for transitions into 2s-state. However for $2p_{\frac{1}{2}}$-levels and some other p-levels which are situated higher of state $2p_{\frac{3}{2}}$ the largest reduced probability is for M1-transition to the $2p_{\frac{3}{2}}$-state. The matrix element of the M1-transition from $2p_{\frac{1}{2}}$ to $2p_{\frac{3}{2}}$-state for ^{29}Si was proved to be equal to its one-particle estimate. For the most probable E1-transition to the state $2s_{\frac{1}{2}}$ the matrix element is equal to only 5.5×10^{-3} of its one-particle value. (auth)

4155 NUCLEON COUPLING EFFECT AND DEPENDENCE OF NUMBER OF INSTANTANEOUS FISSION NEUTRONS ON THE FRAGMENT MASS. Savel'ev, A. E.; Zhikhareva, S. V.; Savel'eva, M. A. Yadern. Fiz.; 16: No. 1, 21-6(Jul 1972). (In Russian).

The dependence of the total number of instantaneous fission neutrons on the fragment mass has been calculated for the case of ^{252}Cf spontaneous fission. It is shown that this dependence is characterized with a fine structure that is absent in the experimental data for the time being. It is noted that a fine structure remains in the case of induced fission also. It has been exhibited that the fine structure in $\bar{\nu}(A)$ is due to the coupling effect of nucleons in fragments. (auth)

4156 SPIN DEPENDENCE OF DENSITY OF PARTICLE-HOLE STATES OF THE ATOMIC NUCLEI IN FERMI-GAS MODEL. Sokolov, Yu. V. (Inst. of Physical Energy, Moscow). Yadern. Fiz.; 16: No. 1, 27-33(Jul 1972). (In Russian).

The expression for a density of particle-hole states of atomic nuclei taking into account the total angular momentum J, has been obtained in the Fermi-gas model. The dispersion of state distributions in J is investigated. (auth)

4157 E2-TRANSITIONS AND QUADRUPOLE MOMENTS OF HIGH SPIN STATES IN COLLECTIVE NUCLEUS MODEL. Budnik, A. P.; Rabotnov, N. S.; Seregin, A. A. (Inst. of Physical Energy, Moscow). Yadern. Fiz.; 16: No. 1, 34-7(Jul 1972). (In Russian).

In the framework of a phenomenological collective model with a potential energy, dependent on deformation coordinates β and γ, the values of the reduced probabilities of cascade E2-transitions and mean values of quadrupole moments in excited states of even–even nuclei with high spin in the ground-state rotational band have been calculated. (auth)

4158 LEVEL DENSITY OF COMPOUND NUCLEI FOR A = 130/200 AND SOME OTHER NUCLEAR PROPERTIES. Vertebnyi, V. P.; Kal'chenko, A. I.; Pasechnik, M. V. (Inst. of Nuclear Research, Kiev). Yadern. Fiz.; 16: No. 1, 38-41(Jul 1972). (In Russian).

Recently some data on neutron resonances for a considerable number of nuclei over a range of A = 130 to 192 have been obtained by the time-of-flight method. These data have been used for calculations of level densities of compound nuclei close to the excitation energy equal to binding energy. The paper presents the data on the dependence of a mean distance between the levels for fixed excitation energy as a function of neutron number in a nucleus. (auth)

4159 NATURE OF INTERMEDIATE STRUCTURE OF DIPOLE ANALOG RESONANCES. Zhivopistsev, F. A.; Shitikova, K. V. (Moscow State Univ.). Yadern. Fiz.; 16: No. 1, 42-9(Jul 1972). (In Russian).

The problem of the influence of the coupling of particle-hole states (with a more complicated type, i.e., two particles—two holes) on the structure of the dipole resonance (2^+, 3^-) has been studied. Numerical calculations are performed for ^{60}Ni and ^{90}Zr nuclei. (auth)

4160 REALIZATIONS OF THE PHYSICAL BASIS OF SU(3) AND THE PROBABILITY OF E2-TRANSITIONS IN SU(3) SCHEME. Afanas'ev, G. N.; Avramov, S. A.; Raichev, P. P. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 16: No. 1, 53-9(Jul 1972). (In Russian).

Within the framework of the SU(3) scheme the probability of transitions has been calculated. It is shown that one may choose the operators Ω_1 and Ω_2 that quite distinctly separate the rotational bands. (auth)

4161 MODEL OF NUCLEAR PHYSICS EQUATIONS. Baz, A. I.; Zhukov, M. V. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 16: No. 1, 60-73(Jul 1972). (In Russian).

An interpolating expression for a multinucleon wave function that provides an adequate description of bound nucleus states as well as of binary decay channels has been constructed. Further, a system of usual differential equations for the wave function that allows one to solve the problems of nuclear reactions and of nuclear structure physics is derived. The same physical parameters enter into these different problems. (auth)

4162 ELASTIC AND INELASTIC GLAUBER SCATTERING OF PROTONS ON ^{12}C NUCLEUS IN α-PARTICLE MODEL. Antonov, A. N.; Inopin, E. V. (Kharkov State Univ.). Yadern. Fiz.; 16: No. 1, 74-80(Jul 1972). (In Russian).

Elastic and inelastic scattering (level 2^+; 4.43 MeV) of protons on ^{12}C nucleus is considered on the basis of Glauber theory and the α-particle model. In this model ^{12}C consists of three α-particles, situated in vertexes of an equilateral triangle. One-, two- and three-fold proton scatterings by α-particles are taken into account. A good agreement with the experimental data (proton energy 1 GeV) has been reached for the case of elastic scattering alongside with the qualitative agreement with the data on inelastic scattering. (auth)

4163 BOUND AND DECAY STATES IN RESONANCE REACTION THEORY. Luk'yanov, A. A. (Inst. of Physical Energy, Moscow). Yadern. Fiz.; 16: No. 1, 88-95(Jul 1972). (In Russian).

A general scheme of nuclear resonance reaction theory using a model Hamiltonian basis with bound and decay states in each open reaction channel is derived. Collision matrix expressions, structure of model bound state widths, "spread" of decay states due to coupling with bound spectrum, and a model of complex potential are discussed. The practical scheme for analysis of a detailed energy structure of cross sections in a wide region with basis states of different types is presented. (auth)

4164 STRUCTURE OF DIPOLE RESONANCE IN THE ^{13}C NUCLEUS IN AN INTERMEDIATE COUPLING APPROXIMATION. Goncharova, N. G.; Sagiyan, G. S. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 13: No. 1, 121-5(1972). (In Russian).

The characteristic feature of photonucleon cross sections in certain nuclei is the "pygmy" resonance. Calculations on the dipole states in ^{13}C on the basis of 1p + 2p + 1h configurations result in much too low a result in the pygmy resonance region. A method is described for calculating photospallation on the dipole excited ^{13}C nucleus on the basis of wave functions of intermediate coupling. (K.S.W.)

4165 LOW LYING ENERGY LEVELS OF ^{133}Xe. Raju, M. L. Narasimha; Satyanarayana, G.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Indian J. Phys.; 45: No. 12, 579-81(Dec 1971).

The low-lying levels of ^{133}Xe were calculated in the framework of the core-excitation model. The $d_{\frac{3}{2}}$ odd neutron was assumed to be coupled to the ^{132}Xe first 2^+ state. The results were compared with experimental data and predictions of the intermediate coupling model. (J.W.R.)

4166 SEPARATION OF THE LIGHT PARTICLE IN THE TERNARY FISSION PROCESS. II. Feather, N. (Univ. of Edinburgh). Proc. Roy. Soc. Edinburgh, Sect. A; 69: No. 4, 335-45(1972).

A previous discussion (Feather 1969a) of the energetics of the separation of an α-particle in the ternary fission of an even–even nucleus (^{236}U or ^{252}Cf) is generalized to cover the case of a light particle of arbitrary mass and charge separating from a fissioning nucleus the nucleon-parity type of which may be any one of the four possible types. A "profitability index" is defined in terms of which certain broad differences in the light-particle spectra from different types of fissioning nucleus are predicted, and the results of detailed calculations of the minimum energy expense of separation are given for various light particles emitted in the fission of ^{236}U and, for comparison, for an α-particle emitted in the fission of ^{238}Np, an odd–odd nucleus. (auth)

4167 DEPENDENCE OF (n,α) CROSS-SECTIONS ON THE SYMMETRY PARAMETER. Choudhury, S. Roy; Kaul, O. N. (Government Engineering Coll., Bilaspur, India). Indian J. Pure Appl. Phys.; 10: No. 3, 197-9(Mar 1972).

Experimental values of (n, α) cross sections in the case of 14–15 MeV neutron-induced reactions show that the reaction cross sections decrease monotonically with increasing asymmetry factor (N–Z)/A and show no appreciable deviations from this behavior in the magic nuclei regions. Plotted against neutron excess, it is observed that the cross sections decrease rapidly for lighter elements and somewhat slowly for heavier elements. Adopting the statistical model approach an attempt has been made to interpret measured (n, α) cross sections empirically and a straight-line dependence of σ(n, α) on (N–Z) is found. It is also pointed out that shell effects can only cause minor deviations from the general trend of decreasing cross section with increasing (N–Z)/A values. The results obtained from the present study agree well with the predicted behavior in the sense that with the increase of Z-value the tendency towards symmetry decreases. (auth)

4168 TWO-NUCLEON TRANSFER WITH HEAVY IONS. Baltz, A. J.; Kahana, S. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Lett.; 29: No. 18, 1267-70(30 Oct 1972).

A distorted-wave Born-approximation calculation of two-particle transfers between heavy ions is presented which does not treat the transferred nucleons as a cluster. Application is made to (^{18}O,^{16}O) reactions on the nuclei ^{92,94,96,98}Mo. (auth)

4169 CALCULATION OF THE CROSS SECTION OF THE REACTION p + A → π^+(A + 1) IN THE SINGLE-PARTICLE MODEL. Amus'ya, M. Ya.; Gridnev, A. B. (Inst. of Nuclear Physics, Leningrad). JETP Lett. (USSR) (Engl. Tranl.); 16: No. 2, 73-5(20 Jul 1972).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 16: No. 2, 105-9(20 Jul 1972).

It is shown that the features of the A(p,π^+)A + 1 reaction may be explained within the framework of the single-particle model. Cross sections for the (p,π^+) reaction on ^{12}C, ^{13}C, and ^{14}N were calculated and compared with experimental data. The results

indicate that contributions from p–n correlations are small. (J.W.R.)

4170 PROTON POLARIZATION IN COULOMB STRIPPING REACTION. Gubkin, I. A. (Leningrad State Univ.). Yadern. Fiz.; 15: No. 5, 917-21(May 1972). (In Russian).

The analytic expression for proton polarization in the Coulomb stripping (d,p) reaction has been obtained for any value of the angular momentum l_n of the captured neutron. This expression is a generalization of the formula obtained for a particular case of the angular momentum $l_n = 1$. It agrees well with the numerical calculation. The proportionality of the polarization and neutron angular momentum at angles close to π and at the total momentum $j_n = l_n + \frac{1}{2}$ has been proved. (auth)

4171 POLARIZATION PHENOMENA IN DIRECT REACTIONS WITH SIMPLE DIAGRAMS BEING TAKEN INTO ACCOUNT. Ots, I. (Inst. of Physics and Astronomy, Tartu). Yadern. Fiz.; 15: No. 5, 922-33(May 1972). (In Russian).

Polarization phenomena in direct reactions were considered taking into account several simple diagrams. Formulas have been obtained for the polarization moments of particles produced and for the angular asymmetry of final particles with initial particles being polarized. Some relations between polarization moments and asymmetry are presented. (auth)

4172 ANGULAR MOMENTUM PROJECTION FROM NON-AXIAL INTRINSIC STATES. Watt, A. (Univ. of Glasgow). J. Phys., A (London); 5: No. 4, 584-95(Apr 1972).

An exact method of angular momentum projection from nonaxial intrinsic states is described. It is shown that the symmetries usually imposed on Hartree–Fock solutions lead to important simplifications in angular momentum projection. (auth)

4173 MICROSCOPIC THEORY OF ODD-MASS NUCLEI. Baktybaev, K. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 6, 1-6(1971). (In Russian).

A microscopic theory of interaction of an odd nucleon with collective excitations of an even nucleus was constructed. The method was based on the conclusion of coupled, linear equations of motion for the amplitude of excitation of the states of odd, spherical nuclei. The excitation of a core of the two particle–two hole type and more complex nuclei was not considered. As an example, the spectrum of ^{17}O was calculated in a diagonal approximation. (tr-auth)

4174 SUMMATION OF SEVERAL SERIES OF SCATTERING THEORY. Arushanov, G. G. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 1, 8-15(1972). (In Russian).

The problem of approximate and precise summation of the series in scattering theory was examined, a part of which is encountered in the theory of elementary particle collisions at asymptotically high energies. The mathematical development makes use of a Legendre polynomial, the Dirac δ-function, Feynmann representation, and a method of summation based on Euler–Makroven. (K.S.W.)

4175 K-SHELL INTERNAL IONIZATION ACCOMPANYING BETA DECAY. Isozumi, Yasuhito; Shimizu, Sakae (Kyoto Univ.). Nippon Butsuri Gakkaishi; 27: No. 1, 44-8(Jan 1972). (In Japanese).

Recent results of study on K-shell internal ionization are reviewed. Early theory explained the process as two-step shake off process, and experiments have been carried out to prove the results based on the theory. Nuclear charge dependence of total ionization probability introduced from the theory is in agreement with the results of experiments. Another probable mechanism of the internal ionization is direct collision of beta particles with orbital electrons due to Coulomb interaction. It was, however, shown that this process cannot be the main process of the ionization. One-step shake off theory was introduced recently and refined. Recent experiment with an air core beta ray spectrometer showed that experimental beta ray spectrum in coincidence with K x ray was in good agreement with that derived from the one-step shake off theory. Another experiment performed by the authors also proved that the experimental ionization probability for low energy beta particles can be explained by the one-step theory. Some ambiguity in the theory are still remains. (auth)

4176 THREE-BODY CLUSTERS IN NUCLEAR MATTER. da Providencia, J. (Univ., Coimbra); Shakin, C. M. Phys. Rev., C.; 6: No. 4, 1455-7(Oct 1972).

An extended derivation of the three-body cluster energy is given which clarifies the presentation in a previously published paper. (auth)

4177 ONE-DIMENSIONAL THREE-BODY SCATTERING PROBLEM USED AS A TESTING GROUND FOR THE K-MATRIX METHOD FOR SCATTERING REACTIONS OF COMPLEX SYSTEMS. Rodjak, D. (Case Western Reserve Univ., Cleveland); Tobocman, W.; Tandon, G. K. Phys. Rev., C.; 6: No. 4, 1192-1211(Oct 1972).

The scattering reactions of three equal-mass particles constrained to move in a straight line and interacting with each other via zero-range potentials are analyzed on the basis of the extended R-matrix theory. The simplicity of the model facilitates an exposition of the complexities that result from the existence of rearrangement channels and from the possibility for breakup into three-body channels. The conventional expressions for the K matrix and the T matrix are derived on a rigorous basis. A practical method for approximating the continuum of three-body breakup channels by a discrete set is used to carry out a distorted-wave Born-approximation (DWBA) K-matrix calculation of the probabilities for transmission, knockout, and breakup when one particle is incident on a bound state of the other two. This method is found to give much better results than a DWBA T-matrix calculation. (7 figures, 6 tables). (auth)

4178 PLANE-WAVE MATRIX APPROACH TO DIRECT REACTIONS. Robson, D. (Princeton Univ., N. J.); Koshel, R. D. Phys. Rev., C.; 6: No. 4, 1125-32(Oct 1972).

A new method based on plane-wave representations is developed and applied to the theory of direct reactions. The coefficients of the plane-wave expansions of propagators are determined either by the requirement that they fit the scattering matrix for an auxiliary potential both on and off the momentum shell or by the use of an effective unit operator. Such expansions lead to the reduction of typical direct reaction problems to simple matrix algebra, the basic matrices being either plane-wave matrices or auxiliary potential matrices. Particular attention is given to finite-range distorted-wave matrix elements and coupled-channels theory, where the possible advantages of the present approach can be understood even at a formal level. (auth)

4179 ESTIMATE OF THE IMPORTANCE OF RETARDATION IN NUCLEAR BINDING. Richards, Keith C. (Franklin Inst., Swarthmore, Pa.); Haftel, Michael I.; Tabakin, Frank. Phys. Rev., C.; 6: No. 4, 1143-50(Oct 1972).

A potential form alternate to the customary Yukawa form is deduced. This nonlocal potential incorporates retardation of the meson and nucleon normalization factors. A phenomenological potential patterned after the Reid soft-core potential is constructed. This new phenomenological potential is compared with the Reid potential off the energy shell. The off-shell changes lead to a decrease in the binding energy of nuclear matter of 1.5 MeV/particle in the $^3S_1 - ^3D_1$ state and an increase of 0.1 MeV/particle in the $^1S_0$ state. (6 figures, 6 tables). (auth)

4180 TEST OF SINGLE-CHANNEL STRENGTH-FUNCTION LIMIT. Devaney, Joseph J. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C.; 6: No. 4, 1162-7(Oct 1972).

By using the exact solution of a particle decaying from a square well, it is shown that the strength function, (Γ/D), is unbounded and has the form $(2\pi\Gamma/D) = -\ln(1 - T)$ suggested by Moldauer (for average parameters), where T is the transmission. (1 figure, 1 table). (auth)

4181 ANALYSIS OF THE TOTAL (n,p) CROSS SECTIONS AROUND 14 MeV WITH THE PRE-EQUILIBRIUM EXCITON MODEL. Braga-Marcazzan, G. M.; Gadioli-Erba, E.; Milazzo-Colli, L.; Sona, P. G. (Centro Informazioni Studi Esperienze, Milan). Phys. Rev., C.; 6: No. 4, 1398-1407(Oct 1972).

The absolute value of (n,p) reaction cross sections, as given by the pre-equilibrium exciton model, is estimated using the Fermi gas approximation. A general agreement with experimental data is obtained, particularly in the gross A dependence. The energy range considered is 10 to 20 MeV, and the nuclei are those with $A > 100$; in these ranges evaporation is negligible and the analysis is rather easy. The approximate lifetime of one single-particle exciton in nuclear matter is also deduced. (6 figures). (auth)

4182 TIME DELAY IN SCATTERING PROCESSES. Jauch, J. M. (Univ., Geneva); Sinha, K. B.; Misra, B. N. Helv. Phys. Acta; 45: No. 3, 398-426(31 Aug 1972).

The relation between time delay and the phase-shift operator is derived in the context of the time-dependent scattering theory for simple (single channel) scattering systems. The sufficient conditions on the interaction under which this relation can be established in a mathematical correct manner are formulated and the precise sense in which this relation can be interpreted is discussed. The results obtained here generalize and unify various partial results previously published on this subject. (auth)

4183 EQUIVALENCE BETWEEN LOCAL AND NONLOCAL POTENTIALS. Capuzzi, F. (Univ., Padua). Nuovo Cim.; 11A: No. 4, 801-16(21 Oct 1972).

The connection between local and nonlocal descriptions of scattering processes is investigated. The analysis is restricted to the case in which the Jost solutions of the nonlocal Schroedinger equation exist. It is shown that under suitable conditions on the nonlocal potential the associated S matrix is reproduced by an uncountable set of local potentials which satisfy the general properties of the phenomenological optical-model potential. (auth)

4184 ESTIMATE OF THE ALPHA–NUCLEUS SPIN–ORBIT POTENTIAL. Rawitscher, George H. (Univ. of Connecticut, Storrs). Phys. Rev., C.; 6: No. 4, 1212-23(Oct 1972).

The spin–orbit part $V_{ls}\vec{l}\cdot\vec{I}$ of the α–nucleus interaction is estimated on the basis of the nucleon–α spin–orbit potential. Here $\vec{I}$ is the spin of the target nucleus and $\vec{L}$ is the orbital angular momentum of α–nucleus relative motion. The calculation assumes that the target nucleus undergoes no virtual excitation during the collision and that core polarization effects are absent. Numerical results are obtained for the nuclei of ^{9}Be, ^{59}Co, and ^{14}N. The result for the two first cases is found to be an order of magnitude smaller than the phenomenological values of $V_{ls}\vec{l}\cdot\vec{I}$ quoted in the literature. For ^{14}N the value of $V_{ls}\vec{l}\cdot\vec{I}$ is nearly 10 times larger than for ^{9}Be, a result which depends on the fact that for the valence nucleon $j = l - \frac{1}{2}$ in the former case, and $j = l + \frac{1}{2}$ in the latter case. For ^{14}N no phenomenological values of $V_{ls}\vec{l}\cdot\vec{I}$ appear to be known. (2 figures, 2 tables) (auth)

4185 STATUS OF SOME RELEVANT PROBLEMS IN NUCLEAR PHYSICS. Amaldi, U. Jr. (Istituto Superiore di Sanita, Rome). pp 450-71 of Elementary Processes at High Energy. Part B. /Zichichi, A. (ed.). New York; Academic Press Inc. (1971).

The experimental problems connected with the low-momentum part of the single-nucleon wave function and the high-momentum components of the nuclear wave function are discussed in terms of quasi-free scattering and elastic electron scattering, respectively. A simple description is given of the very important steps that have been made during the last few years toward a solution of the problem. A comparison is made between theoretical predictions and experimental information. (L.B.S.)

4186 RADIAL MOMENTS OF FOLDING INTEGRALS FOR NONSPHERICAL DISTRIBUTIONS. Satchler, G. R. (Oak Ridge National Lab., Tenn.). J. Math. Phys. (N. Y.); 13: No. 8, 1118-19(Aug 1972).

Simple relations are exhibited between the radial moments of two nonspherical distributions when one is obtained by folding a scalar function into the other. Some applications are mentioned, and the generalization to nonscalar functions is indicated. (auth)

4187 WIDTH OF THE SINGLE AND DOUBLE ANALOGS: A SIMPLE RELATION. Auerbach, N. (Tel-Aviv Univ., Israel). Phys. Lett.; 41B: No. 4, 403-4(16 Oct 1972).

The total width of the double isobaric analog resonance is related to the width of the single analog resonance. An estimate of both widths is given, by using the isovector monopole state as the main doorway in Coulomb mixing. (auth)

4188 CONTRIBUTIONS OF NEUTRONS TO ELASTIC ELECTRON SCATTERING FROM NUCLEI. Bertozzi, W.; Friar, J.; Heisenberg, J.; Negele, J. W. (Massachusetts Inst. of Tech., Cambridge). Contract AT(11-1)-3069. Phys. Lett.; 41B: No. 4, 408-14(16 Oct 1972).

Previously ignored contributions from the neutron charge form factor and the spin–orbit interaction in spin unsaturated shells are investigated. It is shown that at $q = 3$ fm^{-1} approximately 30% of the total cross section in heavy nuclei arises from neutrons and that the seemingly anomalous decrease of the rms charge radius from ^{40}Ca to ^{48}Ca is caused by the $f_{\frac{7}{2}}$ neutrons. The uncertainty in the neutron charge form factor presents a serious difficulty in making accurate comparisons to theoretical models. (auth)

4189 RENORMALIZED CLUSTER EXPANSION. Schaefer, L. (Univ., Heidelberg). Phys. Lett.; 41B: No. 4, 419-20(16 Oct 1972).

The result of a partial summation of the Iwamoto–Yamada cluster expansion valid for infinite systems is presented. The resulting expansion is renormalized by weight factors, which for a special representation of the trial wave function are identical with occupation probabilities. The relation to renormalized Breuckner theory is illustrated by a simple example. (auth)

4190 MAGNETIC MOMENTS OF ODD-MASS NUCLEI WITH SIMPLE CONFIGURATIONS. Arima, A.; Huang-Lin, L. J. (State Univ. of New York, Stony Brook). Phys. Lett.; 41B: No. 4, 535-8 (16 Oct 1972).

Magnetic moments of odd-mass nuclei with simple configurations are calculated by taking into account the core polarization and the mesonic current. The core polarization mechanism is in qualitative agreement with observations. The core polarization produces a large modification of the gyromagnetic ratio, g_s, of the spin angular momentum. This is consistent with information from the observed rates of allowed M1 transitions. The mesonic current has a large effect for states with high spin, because the effect can be approximated by $\delta g_l l$ where l is the operator of orbital angular momentum. The contribution from the mesonic current has the same sign as that from the core polarization in states with $j = l - \frac{1}{2}$. This is desirable, for example, in the $h_{\frac{9}{2}}$ state of ^{209}Bi. On the other hand, those two contributions cancel each other in states with $j = l + \frac{1}{2}$. The recent observations of magnetic moments of the $i_{\frac{13}{2}}$ proton, the $i_{\frac{13}{2}}$ neutron, and the $g_{\frac{9}{2}}$ neutron give rise to a serious new problem. (auth)

4191 ANTISYMMETRIZATION OF MANY-NUCLEON SYSTEMS. Suenkel, W.; Wildermuth, K. (Univ., Tuebingen, Ger.). Phys. Lett.; 41B: No. 4, 439-42(16 Oct 1972).

A new method of antisymmetrizing many-nucleon systems and its application to the elastic α–^{16}O scattering is discussed. (auth)

4192 TOROIDAL NUCLEI. Wong, C. Y. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 41B: No. 4, 446-50(16 Oct 1972).

There are shells in the single-particle spectrum of a toroidal nucleus. The shell-corrected deformation energies, calculated with Strutinsky's theory of renormalization, show breathing deformation minima for $40 \lesssim A \lesssim 70$ and $A \gtrsim 250$ along the beta-stability line. (auth)

4193 BUBBLE NUCLEI. Wong, C. Y. (Oak Ridge National Lab., Tenn.). Phys. Lett.; 41B: No. 4, 451-4(16 Oct 1972).

There are shells in the single-particle spectrum of a bubble nucleus. The shell-corrected deformation energies, calculated with Strutinsky's theory of renormalization, show that ^{36}Ar, ^{84}Se, ^{138}Ce, and ^{200}Hg in their ground or low-lying excited states are bubble nuclei with a small hole in the interior, while ^{174}Yb and ^{250}104 have secondary minima in the bubble degree of freedom. (auth)

4194 TWO-PION-EXCHANGE CONTRIBUTION TO THE $\Delta T = 1$ PART OF THE PARITY-VIOLATING POTENTIAL. Desplanques, B. (Institut de Physique Nucleaire, Orsay, France). Phys. Lett.; 41B: No. 4, 461-4(16 Oct 1972).

The two-pion-exchange contribution to the $\Delta T = 1$ parity-violating potential is derived using dispersion theory methods. The circular polarization for the $\frac{1}{2}^- \rightarrow \frac{3}{2}^+$ transition in ^{41}K is calculated with this potential and compared to the one-pion-exchange contribution. (auth)

4195 DEPOLARIZATION AND THE TENSOR PART OF THE SPIN–SPIN TERM OF THE OPTICAL POTENTIAL. Sherif, H. S.; Hussein, A. H. (Univ. of Alberta, Edmonton). Phys. Lett.; 41B: No. 4, 465-7(16 Oct 1972).

It is shown that the existing depolarization data suggest a large spherical spin–spin term in the optical potential, contrary to both present theoretical estimates and results obtained from the scattering of polarized neutrons by polarized targets. If one accepts the present estimates of a weak spherical spin–spin interaction, then the depolarization data seem to imply an important contribution from the tensor spin–spin potential. (auth)

4196 ABSORPTIVE POTENTIALS AND HEAVY ION ELASTIC SCATTERING. Rickertsen, L. D. (Univ. of Colorado, Boulder). Phys. Lett.; 41B: No. 4, 473-6(16 Oct 1972).

The nature of the gross structure in the optical-model analysis of heavy-ion elastic scattering is investigated. Further, the success of the double-resonance effect in reproducing intermediate structure is studied. (auth)

4197 ENERGY-DEPENDENT TWO-PROTON t MATRIX IN (p,2p) REACTIONS. Strobel, George L. (Kernforschungsanlage, Juelich, Ger.). Phys. Rev. Lett.; 29: No. 20, 1406-9(13 Nov 1972).

Strikingly improved distorted-wave fits to experimental cross sections are obtained for the (p,2p) reaction cross section by including an energy dependence to the two-proton t matrix. The two-proton t matrix used is a local effective t matrix times a factor which reproduces the three-body model energy dependence of a two-proton t matrix resulting from a separable potential. (auth)

4198 LINE BROADENING AROUND THRESHOLD. Zimanyi, J. (Central Research Inst., Budapest); Gyarmati, B. Phys. Lett.; 41B: No. 5, 571-3(30 Oct 1972).

The distribution of the single-particle reduced width on the observed nuclear states was recalculated by taking into account the energy dependence of the occurring quantities in the framework of the uniform model with one channel only and with vanishing background width. In the strong-mixing limit numerical examples

are given showing the compression effect of the threshold on the line broadening. This effect is smaller when the full energy dependence is kept than in a linear approximation. (auth)

4199 STATISTICAL THEORY FOR THE RATIO OF ISOMER TO PROMPT AND NEUTRON TO PROMPT CROSS SECTIONS. Sperber, D.; Aframe, A. (Rensselaer Polytechnic Inst., Troy, N. Y.). Phys. Lett.; 41B: No. 5, 574-6(30 Oct 1972).

A new method for the calculation of the ratios between several cross sections in nuclei in which prompt fission, isomeric fission, and neutron evaporation dominate is presented. The theory gives very good agreement with experiment. (auth)

4200 POTENTIAL SCATTERING IN THE EIKONAL APPROXIMATION. Joachain, C. J.; Mund, E. H. (Univ., Brussels). Bull. Cl. Sci., Acad. Roy. Belg.; 57: No. 9, 1043-53(1971).

The eikonal wave function and scattering amplitude for potential scattering are obtained by using elliptic confocal coordinates to evaluate the total Green's function in the short wave length limit. The derivation provides a simple way of analyzing some of the basic assumptions involved in deriving the eikonal approximation. (auth)

4201 NUCLEAR CORE RENORMALIZATION. I. COULOMB ENERGY DIFFERENCES. Camiz, P. (Univ., Rome); Olivieri, E.; Scalia, M.; D'Andrea, A. Nuovo Cim.; 12A: No. 1, 71-82(1 Nov 1972).

Core renormalization in light nuclei is introduced through a dependence of the core radius on the occupation number of the last shell, in a linear approximation. The corresponding coefficient for the shells $1p_{\frac{3}{2}}$, $1p_{\frac{1}{2}}$, $1d_{\frac{5}{2}}$, $2s_{\frac{1}{2}}$, $1d_{\frac{3}{2}}$, $1f_{\frac{7}{2}}$ is obtained by fitting experimental Coulomb energy differences with a modified Hecht's mass formula, containing four adjustable parameters. Evidence is found for a renormalization effect corresponding to a dilatation of the core. (auth)

4202 EIKONAL EXPANSION OF THE SCATTERING EQUATIONS. Bogdanov, A. V.; Dubrovskii, G. V. (Leningrad State Univ.). Teor. Mat. Fiz.; 13: No. 1, 88-101(Oct 1972). (In Russian).

Generalization of the eikonal expansion of the scattering equations for an arbitrary inelastic process is suggested. In the case of three-body system the first three members in the eikonal expansion for reactions of excitation, dissociation, and rearrangement are found which can be applied to concrete calculations of atomic and molecular processes. (auth)

4203 APPLICATION OF THE HOLE LINE EXPANSION TO AN EXACTLY SOLVABLE MODEL. Petry, H. R.; Schuette, D. (Univ., Bonn). Nucl. Phys.; A195: No. 2, 623-35(1972).

A purely algebraic definition of the hole line expansion is presented. The predictions of the hole line expansion up to fourth order are then investigated in an exactly solvable model which contains an attractive long-range and a repulsive short-range two-body force. Energies and wave functions are studied in relation to the wound integral and the hole–hole interaction. (2 figures, 5 tables) (auth)

4204 NUMERICAL SOLUTION OF THE PARTIAL WAVE LIPPMANN–SCHWINGER EQUATION. Chiang, H. C.; Lee, T. Y. (National Tsing Hua Univ., Hsinchu, Taiwan). Chin. J. Phys. (Taiwan); 10: No. 1, 35-43(Apr 1972).

A simple and efficient numerical solution of the partial wave Lippmann–Schwinger equation is introduced. The singular denominator in the principal value integral is eliminated exactly and the equation is solved by a direct iteration procedure. S-wave scattering amplitude with the Yukawa potential is calculated as an illustrative example. Elastic unitarity constraint is used to test the accuracy of the method. It is shown that the resulting amplitude satisfies the unitarity condition very well. (auth)

4205 INFLUENCE OF NUCLEAR FORCES ON COULOMB FISSION. Holm, Hartmut; Greiner, Walter (Univ., Frankfurt am Main). Nucl. Phys.; A195: No. 2, 333-52(1972).

The influence of nuclear forces on Coulomb fission cross sections is studied in a classical dynamical model and within the quantum-mechanical methods of Coulomb excitation. As examples, the cases of ^{84}Kr, ^{132}Xe, ^{148}Nd, and ^{222}Rn incident on ^{238}U are studied. The nuclear forces counteract the Coulomb force strongly and shift the barrier towards lower energies; therefore, in this region the average excitation energies decrease with increasing incident ion energy. A similar situation holds for the Coulomb fission cross sections, which show a distinct maximum. They are rather large and vary between 1 and 50 mb/sr for backward scattering. (14 figures) (auth)

4206 PAULI EXCLUSION PRINCIPLE IN PRE-EQUILIBRIUM DECAY. Cline, C. K. (Univ. of Rochester, N. Y.). Nucl. Phys.; A195: No. 2, 353-60(1972).

A recent extended version of Griffin's model for nuclear reactions was further modified to include the first-order effects of the Pauli exclusion principle. The resulting changes in the description of nuclear equilibration were studied. Comparisons of the results of calculations made before and after modification indicate that earlier analyses of experimental data carried out with the model are not seriously in error but that in other isolated cases the exclusion principle might become important. The sensitivity of the calculated pre-equilibrium spectra to the Pauli principle is greatest for low-energy, low-mass systems and for complex particle emission. (4 figures) (auth)

4207 A-DEPENDENCE OF THE CRITICAL SPIN IN NUCLEI. Sheline, R. K. (NORDITA, Copenhagen). Nucl. Phys.; A195: No. 2, 321-32(1972).

By using the equation $[(\hbar^2/2\mathcal{I}_{norm}) - (\hbar^2/2\mathcal{I}_{rig})]\, I_{crit}(I_{crit}+1) = \Delta^2/d$, it is possible to estimate the A dependence of I_{crit} resulting from Coriolis antipairing. This estimate gives I_{crit} $(I_{crit}+1) \cong A_{\frac{4}{3}}$. The A dependence of I_{crit} can be compared with experiment by making plots of $2\mathcal{I}/\hbar^2$ versus $(\hbar\omega)^2$ for the observed ground-state rotational bands of a number of deformed even nuclei in the A regions ≈ 22, ≈ 102, and ≈ 126. These plots suggest that the values of I_{crit}, defined as the spin for which the maximum change in moment of inertia is occurring, are ≈ 3, 8 to 10, and 10 to 12 for the A regions ≈ 22, ≈ 102, and ≈ 126, respectively, in agreement with the Coriolis antipairing estimates. The alternative explanation of Stephens and Simon gives $I_{crit}((I_{crit}+1) \cong A^{7}/_{6})$. It is suggested that the two explanations may compete in the region $100 \leqq A \leqq 190$, with the Stephens and Simon explanation relatively more important in the actinide region and less important in the A ≈ 22 region. (6 figures, 2 tables) (auth)

4208 SYMMETRY ENERGY OF EVEN–EVEN NUCLEI. Sauer, G. (Univ., Giessen, Ger.). Z. Phys.; 255: No. 5, 410-18(1972).

The nuclear symmetry energy of even-even nuclei is investigated using a semiempirical formula and a shell model calculation for the Coulomb energy. In order to discuss shell effects in the symmetry parameter the symmetry energy is investigated in terms of changes in the chemical potential by means of the quasiparticle method. (auth)

4209 ROTATIONAL SINGLE-PARTICLE STATES OF NON-AXIAL ODD–ODD NUCLEI. Begzhanov, R. B.; Giyazov, I.; Sharipov, Sh. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 3, 60-3(1972). (In Russian).

The excitation of an odd-odd nucleus must be resolved into collective and single-particle for the theoretical study of its structure. A few excited states cannot be so easily resolved and must correspond to fixed values of parity and the total angular momentum. In the calculations of rotational states of odd-odd nuclei it was assumed that the angular moment of the external odd proton J_p and the odd neutron J_n was conserved. A comparison of theoretical and experimental data on the nuclei ^{64}Cu, ^{190}Au, ^{62}Cu and ^{192}Au showed that the proposed model adequately described the low excited states of odd-odd nuclei. (K.S.W.)

4210 (d,p) REACTION TREATED BY THE FORMALISM OF GREEN'S FUNCTIONS. Froebrich, Peter (Technische Univ., Munich). Z. Phys.; 255: No. 5, 394-404(1972).

The full energy dependence of the two-particle Green's function is taken into account in deriving the S-matrix for a (d,p)-reaction leading from an even-even nucleus in the ground state to a single-particle residual state in the even-odd nucleus. The resulting T-vertex of many-body theory is discussed with the Bethe-Salpeter equation in the particle-particle channel, which allows for a renormalization in the same sense as for bound state problems but now in a different range of energy. Special attention is paid to the problems arising in expanding the deuteron (two particles in the continuum) into shell model wave functions. (auth)

4211 SHELL EFFECT AND α-DECAY PROBABILITY. Keller, K. A.; Muenzel, H. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys.; 255: No. 5, 419-24(1972). (In German).

For the prediction of half-lives for α-decay a semiempirical equation is given. Taking into account a mean excitation energy of the daughter nuclei the constants in the equation for the α-half-lives were reevaluated using the latest published decay schemes. The ratios of experimental and calculated half-lives show a systematic behavior if plotted versus the shell effects. Using this correlation the α-half-lives for unknown nuclides can be predicted with an improved accuracy. (auth)

4212 TREATMENT OF FULL THOMAS COUPLING FOR INELASTIC SCATTERING BASED ON AN EXPANSION IN ORBITAL ANGULAR-MOMENTUM TRANSFER. Verhaar, B. J. (Technische Hogeschool, Eindhoven, Netherlands); Hermans, W. C.; Oberski, J. Nucl. Phys.; A195: No. 2, 379-84(1972).

A method is introduced for the treatment of the full Thomas spin–orbit coupling for collective excitation of nuclei. Unlike previous methods it is based on an expansion of the scattering amplitude in terms of orbital-angular-momentum transfer. As such it lends itself to incorporation of the full Thomas coupling into standard DWBA codes, based on such an expansion. In addition, the expressions obtained are not restricted to spin ½; the introduction of a deformed spin–orbit coupling of the full Thomas form is thus facilitated for deuterons as well. (auth)

4213 MICROSCOPIC THEORY OF INELASTIC SCATTERING OF NUCLEONS BY DEFORMED NUCLEI. I. Sevgen, Alpar (Univ., Freiburg i. B.). Nucl. Phys.; A195: No. 2, 415-48(1972).

A microscopic theory of inelastic scattering of nucleons from rotational nuclei is formulated. Angular-momentum conservation and full antisymmetrization require a careful choice of the many-body basis states for the scattering problem. A very convenient set of basis states $\{X_\xi^c, \Phi\}$ turns out to be a nonorthogonal system. The advantages and properties of this representation are discussed, and the scattering matrix is calculated. Numerical analysis shows that the formalism gives an accurate and practical description of the inelastic scattering by doubly even deformed nuclei and by odd–even rotational nuclei where Coriolis coupling effects are weak. The study of low-energy resonances via the example of the splitting of the s-wave neutron strength function gives additional confidence in this approach. (4 figures, 4 tables) (auth)

4214 NUCLEAR MASS FORMULA AND THE INDEPENDENT PARTICLE MODEL. Wang, C. S.; Hwang, J. L. (National Taiwan Univ., Taipei). Chin. J. Phys. (Taiwan); 10: No. 1, 44-8(Apr 1972).

The attempt of Lee and Green to account for the experimental nuclear mass surface is re-examined in a simplified manner by studying the energy level sequence of the Malenka–Green potential and that of the Wood–Saxon potential both with a spin orbit term. When the energy sum is fitted to the Bethe–Weizsäcker mass formula, the MG potential gives a larger volume energy term a_v and a nearly exact surface energy term a_s; the WS potential also gives a larger a_v but a much smaller a_s. However, the symmetry dependence of the depth of the WS potential proposed by Veje can yield a factor $[1 - \kappa(N-Z)^2/A^2]$ in the Myers–Swiatecki mass formula. (auth)

PHYSICS (PLASMA AND THERMONUCLEAR)

4215 PLASMA PHYSICS INDEX. VOLUME 7, No. 8, 1972. Bibliography, Author Index, Subject Index. Leopoldshafen, Ger.: Zentralstelle fuer Atomkernenergie-Dokumentation (1972). 176p.

This listing contains 530 references on various aspects of the subject. (M.O.W.)

Confinement and Heating

Refer also to abstract 4253.

4216 (AEC-tr-7351) ANOMALOUS RESONANCE IN SHF HEATING OF ELECTRONS IN MAGNETIZED PLASMA. Batanov, G. M.; Sarksyan, K. A. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translated from report NP-19060. 7p. Dep. NTIS.

SHF heating of electrons in a magnetized collisionless plasma was studied experimentally in the region of magnetic fields for which $\omega_{eH}/\omega_0 \geq 1$. In the dependence of the effectiveness of heating on the value of the magnetic field, resonances were detected. The electron heating was the most effective at $\omega_{eH}/\omega_0 \approx 1$, $\omega_{eH}/\omega_0 \approx 1.4 + 1.5$ and $\omega_{eH}/\omega_0 \approx 1.9 + 2$. The dependence of the effectiveness of heating on the plasma density also was of a resonance nature for $\omega_{Le}/\omega_0 > 1$. The detected effects are associated with the parametric excitation of potential waves in the plasma. (auth)

4217 PARTICLE LOSS IN THE LEVITATED SPHERATOR FM-1. Sinnis, J.; Okabayashi, M.; Schmidt, J.; Yoshikawa, S. (Princeton Univ., N. J.). AT(11-1)-3073. Phys. Rev. Lett.; 29: No. 18, 1214-18(Oct 1972).

The plasma confinement times were studied in the levitated spherator FM-1 as a function of the electron density and electron temperature. It was found that below approximately 1 eV, the plasma confinement time is proportional to T_e^m/n_e ($1/2 \leq m \leq 3/4$) with an absolute confinement time 4 to 6 times below the classical confinement time. Above 1 eV, the confinement time decreases as T_e^{-1} with an absolute confinement of 300 times the so-called Bohm diffusion time. (auth)

4218 SIMULTANEOUS ION HEATING OF He^+ AND Ar^+ IN LINEAR TURBULENT-HEATING EXPERIMENTS. Adati, K. (Nagoya Univ., Japan); Kawabe, T.; Oda, T.; (and others). Phys. Rev. Lett.; 29: No. 18, 1223-6(30 Oct 1972).

Turbulent-heating experiments were carried out in a linear machine with a driving gas of helium mixed with 7% argon in order to see the mass dependence of ion heating. Observation of optical line broadening of the ions showed that both kinds of ions were heated almost simultaneously by almost the same amount during the process. Several mechanisms for ion heating are examined on the basis of the experimental results obtained. (auth)

4219 PARTICLE MOTION IN MAGNETIC MIRRORS WITH HIGH-FREQUENCY ELECTRIC FIELD FLUCTUATIONS. Aamodt, R. E. (Univ. of Colorado, Boulder); Byers, J. A. Phys. Rev. Lett.; 29: No. 19, 1305-8(6 Nov 1972).

Particle motion in a magnetic mirror containing high-frequency short-wavelength longitudinal electric fields is followed numerically for many mirror bounce periods. It is found that while the magnetic moment undergoes large rapid changes, these fluctuations seldom imply rapid particle loss from the mirror. This behavior is shown to be completely consistent with nonlinear superadiabatic theory, wherein containment properties of the trap are affected only when particles cross isolated singular surfaces in phase space. (auth)

Diagnostics

4220 (AEC-tr-7347) USE OF DUAL ELECTRIC PROBES FOR MEASURING FLUCTUATIONS AND FLUCTUATING CURRENTS IN TURBULENT PLASMA. Barkov, A. P.; Vasil'ev, M. P.; Pavlichenko, F. F. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated from report KHFTI-70-71. 12p. Dep. NTIS.

The current collected by dual electric probes placed in a homogeneous plasma is given as a function of the plasma density, electron temperature, ion mass, and the potential difference between the probes in the plasma. It was found that at large voltage biases the current on the probe does not approach saturation, but is a linear function of the voltage bias. Good agreement with experiment is obtained by addition of another term to the volt-ampere characteristic equation. It is shown that the correct factor does not depend on the electron temperature and is proportional to the saturation current. The equations are further developed to give the average square of the current fluctuations on the probe as a function of the local temperature, particle density, and electric field. It is possible to judge the predominance of the variation in local temperature or particle density as a function of the voltage between the two probes. Measured and calculated values of particle and energy fluxes in a negative discharge were compared and found to be in good agreement. Anomalous transverse diffusion in a negative discharge is associated with plasma instability. (TTT)

4221 MEASUREMENT OF THE ELECTRON DENSITY IN AN ARGON HOLLOW CATHODE DISCHARGE. Brunet, Andre (ONERA, Chatillon, France). Rech. Aerosp.; No. 4, 237-9(Jul 1972). (In French).

It is shown that it is possible to use electrostatic probes for measuring the plasma density inside the positive column of a hollow-cathode discharge. The ionization process is initiated at the beginning of the incandescent region of the cathode and increases rapidly. (France)

4222 STARK BROADENING OF LINES OF HYDROGENIC IONS. Poquerusse, A. (Ecole Polytechnique, Paris). Phys. Lett.; 41A: No. 5, 453-4(23 Oct 1972). (In French).

The Stark profiles of the first members of a high-order series are calculated for hydrogenic ions in a static electric field. The results are applied to the diagnostics of hot and dense laser-produced plasmas. (auth)

4223 OPTICAL MEASUREMENT OF THE ION TEMPERATURE IN A BARIUM Q PLASMA. Gekelman, W.; Hart, T. R.; Rogers, K. C.; Motz, R. O. (Stevens Inst. of Tech., Hoboken, N. J.). Appl. Phys. Lett.; 21: No. 10, 510-12(15 Nov 1972).

The ion temperature in a single-ended barium Q machine was determined optically, with and without current drawn through the machine. Ion temperatures which were consistent or slightly higher than the hot-plate temperature of 0.25 eV rose to 5 to 7 eV when an electron drift was initiated. The ion temperature rose to 1 eV if an ion current was drawn along the column. These phenomena are independent of magnetic field. (auth)

4224 MEASUREMENT OF THE IONIC PARAMETERS OF A Cs PLASMA USING A GRID PROBE HAVING A COOLED COLLECTOR. Michel, C.; Kornmann, M.; Vicherat, A. (Univ., Nancy). Compt. Rend., Ser. B; 275: No. 5, 207-10(31 Jul 1972). (In French).

The secondary current of the collector of a hot Langmuir probe adversely affects measurements of plasma parameters during ion collection. In order to overcome this problem, a grid probe having a cooled collector was used; the difference between the ionic temperatures measured with a hot probe and cold probe was revealed. (France)

4225 MEASUREMENT OF THE LOCAL ELECTRON DENSITY BY MEANS OF DIRECT-READING MICROWAVE INTERFEROMETER. Zakrzewski, Z.; Sicha, M.; Lubanski, M.; Kopiczynski (Inst. of Fluid-Flow Machines, Danzig). Czech. J. Phys.; 22: No. 8, 641-50(1972).

A microwave x-band interferometer is described in which a Lecher-wire system was applied. The interferometer is suitable for dynamic and local measurements of the electron density in plasma. The sensitivity of the interferometer for a 50-mm path of microwaves in plasma is about 4×10^9 cm^{-3}. The spatial resolutions in two directions perpendicular to the Lecher line axis are about 10 and 5 mm. (auth)

Kinetics (General)

4226 (AEC-tr-7354) INTERACTION OF PLASMA STREAMS WITH STATIONARY, AXIALLY SYMMETRIC MAGNETIC FIELDS. Azovskii, Yu. S.; Guzhovskii, I. T.; Khizhnyak, N. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated from report KHFTI-70-50. 101p. Dep. NTIS.

Theoretical and experimental investigations of the interaction of plasma currents with axisymmetric magnetic fields are discussed. A model of a "small compressible plasma bunch" is used for the theoretical description. Deformation, induced azimuthal current, heating and electric polarization of the plasma during interaction with an axisymmetric magnetic field are examined within the

framework of this model; unmagnetized and magnetized bunches are examined. Hall current in a stationary incompressible flow is examined in magnetohydrodynamic approximation. The interactions of plasma flows with magnetic fields of a solenoid, short coil, two coils hooked up head-to-head, and a space-periodic magnetic field are subjected to experimental analysis, and the changes of the basic parameters of the plasma flow (density, velocity, radius, temperature, induced current, and electric field of polarization) are determined. The theoretical and experimental results are compared. (auth)

4227 (IPP-IV-39) HCN LASER SOURCE FOR COHERENT SCATTERING FROM WAVES IN STATIONARY PLASMAS. Gehre, O. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jul 1972. 29p. (In German). Dep. NTIS (U. S. Sales Only).

Coherent scattering from plasma waves is a useful tool for diagnostics in experiments on plasma confinement and heating. In the density range 10^{11} to 10^{14} cm^{-3} and for temperatures of some eV to 1 keV, which includes today's stellarator- and tokamak-type plasmas, a source in the far-infrared is necessary. The 337-μ line of the HCN laser with a cw power around 100 mW is found to be usable if a high-sensitive whisker detector in a heterodyne mode of operation is used for the detection of the scattered light. The construction and working of an HCN laser intended for a scattering experiment are described. (auth)

4228 DYNAMICS OF PLASMA NONHOMOGENEITY IN CROSSED E × H FIELDS. Studenkov, A. M. (Ioffe Inst. of Physics and Tech., Leningrad). High Temp. (USSR) (Engl. Transl.); 10: No. 1, 18-23(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 22-8(1972).

Under determined conditions, the rate of motion of a plasma nonhomogeneity in crossed E × H fields considerably exceeds the rate of the transverse drift of the ionic component under the action of a Hall polarizing electrical field: this is due to the so-called phase mechanism, in which the current channel "sprouts out of" the Debye layer near the anode. The present article considers a theoretical model which clarifies experimental results obtained earlier. (auth)

4229 PLASMA INJECTION DEVICE. Guillaneux, Pierre; Patou, Claude; Tonon, Gianfranco (to Commissariat a l'Energie Atomique). French Patent 2,102,741. 7 Apr 1972. Filed 19 Aug 1970. (In French).

A plasma injection device was developed that converts the kinetic energy of the plasma ions into thermal energy. In this way the temperature of the plasma is increased and a hot dense plasma can be obtained. This is accomplished by producing a magnetic field having a convergent nozzle-type configuration such that a steep gradient exists between the magnetic field at the entrance of the nozzle and that at the neck, the magnetic lines of force being sensibly perpendicular to the axis of the nozzle. A plasma is produced (e.g., by a laser beam incident on a solid source) at the nozzle entrance, the magnetic field injecting the plasma from the entrance up to the neck of the nozzle. (France)

4230 MEASUREMENTS OF THE CONTACT POTENTIAL BETWEEN AN EMITTING ELECTRODE AND A PROBE WITHIN A PLASMA. Amemiya, H.; Wiesemann, K. (Univ., Marburg, Ger.). J. Phys., D (London); 5: No. 10, 1829-36(Oct 1972).

The distribution function of electrons emitted by an electrode is used as an indicator for the bias necessary to bring the surface of a probe on the potential of the emitting electrode. This bias is equal to the contact potential between probe and electrode. The method is applied to measure changes in the work function of an alkaline-earth cathode in a gas discharge, which appear when the cathode temperature and the discharge current change. A poisoning of the cathode by electronegative gases escaping from the cathode itself is found to be the most plausible explanation of this effect. (auth)

4231 ISOTOPE EFFECT IN ATOMIC SPECTRUM OF HYDROGEN AND DEUTERIUM CONTAINED IN THE PLASMA OF DIRECT-CURRENT ARC DISCHARGES. Vukanovic, D. D. Rad. Zavoda Fiz.; 8: 33-7(1970). (In Serbo-Croatian).

Separation of deuterium and hydrogen was found in the dc arc discharge as used under normal conditions for spectrochemical analysis. The atomic component of the heavier isotope was enriched in the plasma of the arc, especially near the cathode. (H.B.G.)

4232 PLASMA IN A SHIELDED VOLUME. Gorgoraki, V. I. (Inst. of General and Inorganic Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 204: No. 1, 63-5(1 Mar 1972). (In Russian).

A plasma is described which was observed in a shielded space, stripped of any field. Such a plasma is stable and homogeneous in cross section. Tests were conducted with a container having a heated cathode and a plane anode, and its characteristics were determined at voltages from 80 to 100 V for argon gas at 9×10^{-3} torr. A Maxwellian distribution of electron velocities was observed, and an electron temperature of 40,000°K was found. Such studies contributed to the concept of the nature of low-temperature plasma. (K.S.W.)

4233 PLASMA ELECTRON CAPTURE BY A WAVE FIELD EXCITED BY AN ION BEAM. Gabovich, M. D.; Soloshenko, I. A.; Simonenko, L. S. (Inst. of Physics, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 8, 1362-4(Aug 1972). (In Russian).

The interaction of an ion beam with a plasma was employed to experimentally detect the effect of plasma electron capture by a wave field. A beam of 30-keV H_2^+ ions (20 mA current) caused the ionization of a neutral gas ($\sim 10^{-5}$ mm Hg) to form a plasma with 10^7 to 10^8 particles/cm^3. The distribution of the amplitude of the fundamental harmonic of the modulated beam along the axis of the beam at 27 MHz was investigated at various modulating voltages. The data indicated that electron capture had occurred. (K.S.W.)

4234 EFFECT OF A DECREASE IN THE IONIZATION ENERGY ON THE RADIATION CONTINUUM OF AN ARGON PLASMA. Goldbach, C.; Nollez, G. (Centre National de la Recherche Scientifique, Paris). Compt. Rend., Ser. B; 275: No. 3, 137-40(17 Jul 1972). (In French).

The decrease in the ionization energy of the background continuum was determined at 1.10 and 30 atm. The effect of this decrease on the values measured for the Biberman–Schlueter function $\xi(\lambda,T)$ was studied. (France)

Kinetics (Experimental)

4235 TRANSIENT LIGHT EMISSIONS FROM A LASER PERTURBED PLASMA. Baldis, H. A.; Nodwell, R. A.; Meyer, J. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 50: No. 19, 2338-47(1 Oct 1972).

The interaction between a 20 MW Q-switched ruby laser pulse and a partially ionized argon plasma was studied experimentally. When the focused laser pulse is fired into the plasma, a transient emission from the plasma may be observed both in the continuum and line emission. From measurements of the absolute intensities of this transient radiation, estimates were made of the population density of the excited atoms and of the electron densities. The Stark broadening of the Ar-II lines was also measured to obtain the electron density in the transient plasma and data obtained in this way are consistent with those obtained from the continuum radiation. During the time when the laser light is incident on the plasma the Ar-II lines show a strong asymmetry that disappears quickly after the laser pulse has terminated. This asymmetry can be explained in terms of the electron density gradient present in the expanding perturbed plasma. (auth) (Canada)

4236 STUDIES ON A MICROWAVE DRAGGING TECHNIQUE FOR MEASURING ELECTRON DRIFT VELOCITY. Gray, R. B.; Makios, V. (Carleton Univ., Ottawa). Can. J. Phys.; 50: No. 18, 2074-81(15 Sep 1972).

The measurement of electron drift velocity in a low-pressure gas discharge, by a microwave analogue to Fizeau's dragging experiment, is considered. The technique involves the measurement of the phase difference between two electromagnetic waves at microwave frequencies, propagating in opposite directions through the discharge, and relating this phase difference to the electron drift velocity in the discharge. A model is developed that provides this relationship and some phase differences are computed for several situations of interest. It is shown that the dragging effect can be quite large if the plasma is magnetized. In particular, the use of the right-hand circularly polarized wave appears appropriate for electron drift velocity measurement in a longitudinally, magnetized gas discharge. (auth)

4237 INTERACTION OF A PLASMA CURRENT WITH AN AXIALLY SYMMETRIC MAGNETIC FIELD. Kashkin, Yu. F. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 37-9(1972). (In Russian).

The motion of a plasma current in an axially symmetric magnetic field was examined with a magnetic Reynolds number of $R_m \approx 10$, the MHD parameter of interaction $N \approx 1$, and a Hall parameter $\beta \approx 1$. A retardation of the current of large cross section at the inlet in the magnetic field was investigated, allowing for the formation of a loop of azimuthal electric current. (tr-auth)

4238 PENETRATION OF A MAGNETIC CONSTRICTION BY INTENSE RELATIVISTIC ELECTRON BEAMS. Benford, J.; Ecker, B. (Physics International Co., San Leandro, Calif.). Appl. Phys. Lett.; 21: No. 9, 415-17(1 Nov 1972).

An experiment to observe propagation and compression of an intense relativistic electron beam in a tapered linear pinch resulted in beam penetration of the magnetic field constriction at the discharge's narrow end, contradicting the single-particle model verified in earlier experiments using axially uniform pinches. Transverse beam pressure overcame the net pinch pressure, expanding the magnetic constriction and allowing beam passage. (auth)

Kinetics (Theoretical)

4239 (AEC-tr-7348) BREMSSTRAHLUNG OF RELATIVISTIC PLASMA. Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Fizicheskii Institut). Translated from report NP-18758. 22p. Dep. NTIS.

A general theory of bremsstrahlung that takes into account the processes of spontaneous and induced emission and the influence of emission processes on plasma particle distribution (quasi-linear effects) is formulated. (auth)

4240 (COO-2200-1) NUMERICAL SIMULATIONS OF PLASMAS WITH SMOOTHING IN PHASE SPACE AND FILTERING IN TIME. Progress Report, February 1, 1972-September 30, 1972. Denavit, J. (Northwestern Univ., Evanston, Ill.). [nd]. Contract AT(11-1)-2200. 11p. Dep. NTIS.

The research is directed toward the development of numerical simulation methods for collisionless plasmas using (a) periodic smoothing in phase space and (b) filtering in time, and the application of these methods to physical problems of current interest to controlled thermonuclear research. During the past eight months, research on the project was concentrated on Part (a). A computer program was developed and tested to simulate plasma dynamics with self-electric and -magnetic interactions, and a numerical study of trapping effects on the evolution of whistler wave trains, using this computer program, was initiated. (auth)

4241 (IPP-6/111) MACROSCOPIC EQUILIBRIA OF RELATIVISTIC ELECTRON BEAMS IN PLASMAS. Kueppers, G.; Salat, A.; Wimmel, H. K. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jul 1972. 30p. Dep. NTIS (U. S. Sales Only).

Macroscopic equilibria of relativistic electron beams in plasmas, with return current and with or without an external magnetic field parallel to the beam, are investigated in cylindrical geometry. Bennet-type identities and general solutions are derived, and special examples are considered, in particular, low-net-current, quasi-neutral configurations. A general expression for the current screening factor is obtained. Because of screening, relaxed versions of the Alfvén-Lawson conditions determine whether beam propagation is possible. These conditions are easily satisfied for low perpendicular temperatures and sufficiently diffuse density profiles of the beam; they do not limit the beam current. Only equilibria with zero total charge and nonzero total net current and beam profiles without sharp boundary can be obtained from the equations and boundary conditions used. (auth)

4242 (IPP-IV-40) OBSERVATION OF HIGH-ORDER STIMULATED RAMAN-ANTISTOKES RADIATION AND ITS ROLE IN THE INITIAL PHASE OF PLASMA PRODUCTION BY LASERS. Mennicke, H. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jul 1972. 52p. (In German). Dep. NTIS (U. S. Sales Only).

A new model for the production of the first free electrons in a laser-produced hydrogen plasma is presented. According to this model, light of strongly enhanced quantum energy — compared with the quantum energy of the input laser light — is produced by high-order stimulated Raman-antiStokes scattering during the initial phase of the laser-matter interaction. Production of the first free electrons is then achieved by photoionization due to the high-order Raman-antiStokes radiation. Possibilities for dissociation of hydrogen molecules are also briefly discussed. In corresponding experiments, solid hydrogen, deuterium, and nitrogen targets were irradiated with high-intensity ruby laser light (10^{12} W/cm^2). Raman-antiStokes emission was observed spectroscopically for N_2 up to the 12th, D_2 up to the 10th, and H_2 up to the 7th order. The shortest observed wavelength was 2260 Å. Time-resolved intensity measurements of the transmitted laser light, the Raman light, and the original laser light show that the Raman processes occur just before breakdown is observed. These experimental results corroborate the proposed theoretical model of the initial phase of laser-induced plasma breakdown. (auth)

4243 (IPP-IV-41) TRANSIENT PROCESSES DUE TO INTERACTION OF SHOCK PRODUCED PLASMA FLOWS WITH MAGNETIC FIELDS: A THEORETICAL INVESTIGATION. Sardei, F. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Aug 1972. 104p. (In German). Dep. NTIS (U. S. Sales Only).

Transient processes due to the interaction of plasma flows behind strong shock waves with transverse magnetic fields are theoretically investigated. After the model is described, basic problems relating to the formation of a reflected shock are analytically treated. The detailed development of the entire interaction process is then numerically evaluated, and these values are compared with experimental results. It is shown that, under certain conditions, the origin in space and time of the reflected shock can already be determined with relatively simple calculations. Under general conditions, on the other hand, the development of the entire interaction process can only be obtained by numerically solving the complete mathematical problem. The plots of the calculations allow all essential phenomena involved in the interaction process to be recognized and interpreted. In particular, the influence of the interaction parameter and the ionization energy on the flow pattern is clarified. Direct comparison with experimental results is allowed by using measured values of the current in the calculations to obtain three different approximations for the current density. The best agreement is achieved with calculations in which the measured current is inserted as a function of space and time. This also enables the influence of relaxation effects and electrode boundary layers on the current density to be taken into account. Very good agreement is thus obtained for the space and time origins of the reflected shock. (auth)

4244 ELECTRICAL CONDUCTIVITY OF A NON-DEBYE PLASMA. Rovinskii, R. E. High Temp. (USSR) (Engl. Transl.): 10: No. 1, 1-5(1972).

Translated from Teplofiz. Vys. Temp.: 10: No. 1, 1-6(1972).

Semi-empirical formulas are obtained that permit calculating the frequency of electron-ion collisions and the electrical conductivity of a slightly nonideal, non-Debye plasma when there is no strictly valid theory. The formulas differ from the known theoretical relationships for a Debye plasma by a functional factor that can be interpreted as the effective charge of an ion. The experimental dependence of the introduced factor on the temperature of the plasma, the concentration of electrons, and the ionization potential of the gas is found. (auth)

4245 CALCULATION AND INVESTIGATION OF THE ELECTRICAL CONDUCTIVITY OF LOW-TEMPERATURE PLASMAS. Brzhezitskii, V. A. (Inst. of Electrodynamics, Kiev). High Temp. (USSR) (Engl. Transl.): 10: No. 1, 6-17 (1972).

Translated from Teplofiz. Vys. Temp.: 10: No. 1, 7-21(1972).

Presently known recommendations for the calculation of the electrical conductivity of a low-temperature plasma are evaluated, and a number of proposals for engineering calculations of the electrical conductivity are justified. (35 references) (auth)

4246 DIFFUSION APPROXIMATION OF KINETIC EQUATIONS FOR IONIZATION PROCESSES. Zimin, A. G. High Temp. (USSR) (Engl. Transl.): 10: No. 1, 34-9(1972).

Translated from Teplofiz. Vys. Temp.: 10: No. 1, 41-8(1972).

The kinetic equations of a plasma are analyzed for conditions of multiple ionization with an account of transitions between excited states of the ions. With the diffusion approximation proposed, direct transitions to the continuum can be taken into account, and a hyperbolic diffusion equation can be found. This equation describes the diffusion (at a finite rate) of transitions between statistical states of the quantum system; in the limit of small energy jumps, this equation converts into the Kolmogorov (Fokker-Planck) equation. Representation of the system of kinetic equations by a hyperbolic differential equation corresponds to a smoothing of the discrete spectrum of statistical amplitudes, while the discreteness properties of the transition probabilities are retained. The diffusion equation is solved jointly with equations for the temperatures by a moment method for the case of multiple ionization behind the front of a strong shock wave. The results found by means of the diffusion equation agree well with those found from the exact system of kinetic equations. (auth)

4247 EQUALIZATION OF THERMOELECTRIC EMISSION IN A PLASMA. Ostretsov, I. N.; Petrosov, V. A.; Porotnikov, A. A.; Rodnevich, B. B. Zh. Prikl. Mekh. Tekh. Fiz.: No. 3, 40-5(1972). (In Russian).

The equalization of a thermoelectric emission from hot cathodes in a low-temperature plasma was investigated. A distribution function for the magnitude of the intensity of the electric field was obtained at the cathode surface, allowing for the influence of individual fields of separate ions moving in a layer adjacent to the cathode. The thermo-emission current density was found to be caused by field fluctuations which appeared to be substantially higher than that calculated by Richardson's formula using the corrections of Schottky. (tr-auth)

4248 INTENSITY OF SPECTRAL LINES IN PLASMA IN A BURNUP REGIME. Sholin, G. V.; Kitainer, A. G. (Inst. of Atomic Energy, Moscow). Dokl. Akad. Nauk SSSR; 203: No. 4, 802-5(1 Apr 1972). (In Russian).

Calculations were made on a neutral gas under homogeneous conditions, wherein the gas should "burn up," the ionization rate exceeding the recombination rate. Neutral He, with singlet and triplet systems, should accordingly yield intensities of singlet and triplet lines in a dependence on electron temperature in an optically thin plasma. Calculations with the aid of a burnup model confirmed this. The limits of applicability of the model used are discussed. (K.S.W.)

4249 PARAMETERS AFFECTING THE THEORETICAL CALCULATION OF THE THERMAL CONDUCTIVITY OF A NITROGEN PLASMA. Mourgues, W.; Fauchais, P. (Univ., Limoges, France). Compt. Rend., Ser. B; 275: No. 7, 251-4(16 Aug 1972). (In French).

The thermal conductivity, λ, of a nitrogen plasma at atmospheric pressure was calculated for temperatures between 5000 and 18000°K. The results obtained demonstrate that a change of 10% in all the collision terms (this corresponds to the uncertainty in the published values) leads to a maximum variation in λ of 12% (at 18000°K). Very often this variation is less than 4%. (France)

Production

Refer also to abstract 4242.

4250 DENSE PLASMA COLUMNS OBTAINED FROM HOLLOW-CATHODE DISCHARGES. Naoulo, M.; Pham-tu-Manh (Paris Univ., Orsay, France). J. Phys., D (London); 5: No. 10, 1865-9(Oct 1972).

With a hollow-cathode arc discharge used as a plasma source, plasma columns with high densities and low electron temperatures are obtained; these characteristics make them suitable for beam–plasma interaction experiments in the uhf domain. (auth)

4251 PARAMETERS OF A PLASMA PRODUCED BY AN ELECTRON CYCLOTRON RESONANCE HEATING PLASMA GUN. Masuda, M.; Tanaka, Y.; Okuda, T. (Nagoya Univ., Japan). J. Phys., D (London); 5: No. 10, 1861-4(Oct 1972).

Plasma parameters of a plasma produced by a slotted cylindrical microwave cavity are investigated experimentally, and two components of electron temperature are observed. When the neutral gas pressure is decreased, both the temperature of the hot component and the energy density increase. The electron temperature rises at a rate of approximately 2 to 4.5 MeV s^{-1}. This suggests that the heating mechanism is similar to that of the electron cyclotron resonance heating experiments in a magnetic mirror geometry. (auth)

Stability

Refer also to abstract 4286.

4252 (AD-740870) VARIOUS PLASMA-STABILIZATION METHODS FOR CONTROLLED THERMONUCLEAR FUSION: COMPARISON AND ANALYSIS. Ma, B. M. (Iowa State Univ. of Science and Technology, Ames. Engineering Research Inst.). Apr 1972. 79p. (ERI-72075; AFOSR-TR-72-962). NTIS.

To improve the stability and containment time of plasma in a magnetic field, the plasma stabilization for controlled thermonuclear fusion must be developed. The methods or principles of magnetic shear, magnetic well, dynamic, and feedback stabilization are of primary importance and are given primary consideration. The objectives of this research are to: review various stabilizing methods; compare the effectiveness, advantages and disadvantages of some stabilizing methods; and deduce from the results obtained a new idea or original method for understanding plasma instability and improving plasma stabilization. (auth) (GRA)

4253 (CONF-720705-5) PARAMETRIC INSTABILITY AND ITS INDUCED HEATING. Chu, T. K. (Princeton Univ., N. J. Plasma Physics Lab.). 1972. Contract AT(11-1)-3073. 15p. Dep. NTIS.

From first topical conference on rf plasma heating; Lubbock, TX. (6 Jul 1972).

Laboratory experiments having high-frequency excitation electric fields near ω_{pe} are reviewed. Effects of the inhomogeneity of plasmas are discussed, and the potential use of parametric instability in plasma heating is assessed. (auth)

4254 (FRNC-TH-247) APPLICATION OF KINETIC GAS THEORY TO PLASMA PHYSICS AND THE DYNAMICS OF GALAXIES. Petit, J. P. (Aix-Marseilles Univ. (France)). 1972. 199p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The parameters of a non-Lorentzian plasma are calculated from the Boltzmann equation. Gravitational instability in a Maxwellian medium (Jeans equation, Hubble law) is studied. A three-dimensional model of a self-gravitational stellar system is obtained by introducing a particular Schwarzchild solution into Vlasov equation. The rotation curves obtained are in agreement with the results of observations (Bradt motion) for the case of galaxies. The behavior of interstellar space with respect to gravitational instability is analyzed. The structures of different types of galaxy are explained. The electrothermal instability in Hall and Faraday generators were studied. The calculation of the critical Hall parameter and the rate of growth of the instability is extended to treat the case of partially ionized plasma. The possibility of using closed cycle conversion is discussed. (France)

4255 (IPP-1/128) REVIEW OF LINEAR, E x B DRIFT INSTABILITIES. Sanderson, J. J. (Max-Planck-Institut fuer Plasmaphysik, Garching (West Germany)). Jul 1972. 20p. Dep. NTIS (U. S. Sales Only).

The linearized Vlasov–Maxwell system of equations has been used extensively to calculate growth rates of instabilities in plasmas supporting particle drifts. This report reviews some recent results in which the basic drift is the electron $E \times B$ drift but other electron drifts due to plasma and magnetic field inhomogeneities are also present. All gradients are taken in the same direction, so the results are of possible application to collisionless shock waves. (auth)

4256 IDENTIFICATION OF TRANSVERSE KELVIN-HELMHOLTZ TURBULENCE IN A MAGNETOPLASMA COLUMN. Robinson, J. E.; Lidsky, L. M. (Massachusetts Inst. of Tech., Cambridge). Can. J. Phys.; 50: No. 15, 1782-8(1 Aug 1972).

Transverse Kelvin–Helmholtz turbulence was observed in a region of strong rotation and shear in a magnetoplasma column produced using a Lisitano structure. The turbulence is identified on the basis of radial density–potential fluctuation phase, wave localization, and steady-state characteristics of the column. A modified wave equation is used to check experimental observations with theory. This is a second type of magnetoplasma column where transverse Kelvin–Helmholtz turbulence was identified and it supports previous investigations in Q machines. (auth) (Canada)

4257 DRIFT INSTABILITY IN PLASMAS WITH NONUNIFORM MACROSCOPIC ROTATION PROFILES. Caplan, M.; Capjack, C. E.; James, C. R. (Univ. of Alberta, Edmonton). Can. J. Phys.; 50: No. 16, 1795-9(15 Aug 1972).

The drift instability is examined in a collisionless low-β plasma in the presence of nonuniform radial electric fields in the limit where charge neutrality cannot be assumed. A numerical solution and a Weber–Hermite approximation for the resulting differential equation describing the drift instability are presented. (auth)

4258 OBSERVATION OF A PARAMETRIC INSTABILITY NEAR THE LOWER HYBRID-RESONANCE FREQUENCY. Hooke, W. M.; Bernabei, S. (Princeton Univ., N. J.). Contract AT(11-1)-3073. Phys. Rev. Lett.; 29: No. 18, 1218-21(30 Oct 1972).

A parametric instability is observed at frequencies close to and above the lower-hybrid-resonance frequency. The threshold occurs when the electron drift velocity is of the order of the plasma sound speed. At pump-power levels well above threshold the energy in the decay waves is comparable to that associated with the pump wave. (auth)

4259 NONLINEAR EVOLUTION OF THE RAYLEIGH–TAYLOR INSTABILITY OF A THIN LAYER. Ott, E. (Naval Research Lab., Washington, D. C.). Phys. Rev. Lett.; 29: No. 21, 1429-32(20 Nov 1972).

An exact, closed-form, nonlinear solution is obtained for the Rayleigh–Taylor instability of a thin fluid layer. If the layer evolves from a small sinusoidal perturbation, its subsequent shape is in the form of a cycloid. The solution is good up to a time t^* after which adjacent segments of the layer begin to collide with each other. A qualitative discussion of the layer dynamics for $t > t^*$ is given. (auth)

Thermonuclear Processes

Refer also to abstracts 2360, 3112, 3147, and 3156.

4260 (AEC-tr-7174(Vol.2), pp 312-16) TRANSVERSE INSTABILITY OF A PROTON BEAM DUE TO COHERENT INTERACTION WITH A PLASMA IN A CIRCULAR ACCELERATOR.

Dimov, G. I.; Dudnikov, V. G.; Shamovskii, V. G. (Inst. of Nuclear Physics, Novosibirsk, USSR). Translated from Trudy Vsesoyuznogo Soveshchaniya po Uskoritelyam Zaryazhennykh Chastits.

From National particle accelerator conference; Moscow, USSR (9 Oct 1968).

4261 (AEC-tr-7356) RESONANCE PHENOMENA IN CONFIGURATIONS WITH HELICAL MAGNETIC AXES WHEN CALCULATING TOROIDALITY. II. Aleksin, V. F.; Nemov, V. V.; Shishkin, A. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated from report KHFTI-71-13. 10p. Dep. NTIS.

Resonance phenomena in configurations with helical magnetic axes are examined during the turning into a torus. Not only is the region of the exact resonance studied, but the approaches to this region from the nonresonance zone are examined as well. It is pointed out that the magnetic structure may become complicated if a certain characteristic frequency, ω_0, shifts from its resonance value. (auth)

4262 (CONF-721111-3) REVIEW OF ORNL FUSION REACTOR TECHNOLOGY STUDIES (NOVEMBER 1971-NOVEMBER 1972). Steiner, Don (Oak Ridge National Lab., Tenn.). 1972. 5p. Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX. (20 Nov 1972).

Strain-gage measurements on the surface of a 1/8-scale plexiglas model of the BLASCON sphere were made to determine the effects of air bubbles in water on shock waves from a small explosion. The blast was created by exploding a fine wire with an electric current discharge using a power input of 200 joules. Results were obtained to compare the effects of static water, a vortex without air bubbles, and a vortex with air bubbles. It was found that the wall strain was reduced by a factor of 8 when a small vortex with fine air bubbles was employed as compared to a vortex without air. Work is in progress to obtain photographs of the air-water mixture lighted at the vertical midplane by a collimated light beam so that the bubble size and void fraction distribution may be determined. Analytical studies now in progress will provide: (a) guidance for future tests and (b) a basis for scaling results from small systems to a full-scale system. (auth)

4263 (KFK-1610) CONSTRUCTION AND TEST OF A DEVICE FOR PRODUCTION OF HOLLOW CYLINDRICAL CLUSTER BEAMS OF HYDROGEN. Burghoff, H.; Neugebauer, A. R. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Kernverfahrenstechnik). Feb 1972. 37p. (In German). Dep. NTIS (U. S. Sales Only).

It has been shown previously that a hollow-cylindrical beam of nitrogen clusters can be produced by expansion of nitrogen gas out of a ring shaped nozzle cooled by liquid nitrogen. An electrical discharge along this beam produces a plasma of corresponding shape. Since plasmas of the heavy hydrogen isotopes in configurations of this kind may be of interest to produce intense neutron flashes by nuclear fusion it was decided to build a device for production of hollow-cylindrical cluster beams of hydrogen. This paper describes the design, construction, and test of a liquid-hydrogen-cooled cluster generator that produces a pulsed cluster beam of 40 mm I.D. and a pulse length of several milliseconds. In the discharge region the particle density in the beam is of the order of 10^{16} H_2 molecules/cm^3, whereas the interior contains only ca 1% of total amount of material concentrated in the beam. This should be an advantage for the generation of intense neutron flashes. (auth)

4264 (LA-4964) REGULATION OF 2.5-MW DC POWER SUPPLY TO 0.01 PERCENT. Rand, John L. (Los Alamos Scientific Lab., N. Mex.). Sep 1972. Contract W-7405-eng-36. 48p. Dep. NTIS.

This report presents the theory and application used to divide an existing 2.5-MW rectifier into two 1.25-MW dc supplies, add series-pass transistor regulators, and build a control system that will hold current in a solenoid load within 0.01%, up to 9 kA, against power-line transients or changes in load resistance. (auth)

4265 (LA-DC-72-1325) REVERSIBLE MAGNETIC ENERGY TRANSFER AND STORAGE SYSTEMS. Thomassen, K. I. (Los Alamos Scientific Lab., N. Mex.). [nd]. 23p. (CONF-721111-4). Dep. NTIS.

From International meeting on the technology of controlled thermonuclear fusion experiments and the engineering aspects of fusion reactors; Austin, TX. (20 Nov 1972).

A system for transferring energy and recovering it reversibly in a torque-free system was proposed earlier (Smith and Lewin, Particle Accelerators, Vol. 1, p. 155, 1970) for energy transfer in the proposed CERN synchrotron. This idea was adopted in the design of transfer systems in the theta-pinch reactor. Two possible designs are discussed and their problems enumerated. (M.O.W.)

4266 (LBL-915) LARGE-AREA UNIFORM QUIESCENT PLASMA SOURCE FOR HIGH-CURRENT ION BEAM PRODUCTION. Ehlers, K. W.; Kunkel, W. B. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 10p. (CONF-720948-10). Dep. NTIS.

From second international conference on ion sources; Vienna, Austria (11 Sep 1972).

To obtain the multi-ampere deuterium ion beams needed for neutral injection into controlled fusion devices, ion sources that can generate a high-ion-current density over a very large ion extraction area are required. In addition, the ion extraction optics demand that the source provide a quiescent plasma that is uniform in density over the entire ion-extracting region. The design and operation of a pulsed plasma source that meets these demands is described. The source can generate a deuterium ion-current density greater than 0.5 A/cm^2. Probe and extracted current measurements indicate that the plasma is uniform to better than ±10% over a 10-cm diameter (78 cm^2). The plasma is produced by a pulsed (30 msec) low-pressure high-current discharge between a ring of 20 half-millimeter-diameter hot tungsten filaments and an annular anode. No externally applied magnetic fields are required. The elimination of magnetic fields results in a very stable and quiescent plasma with fluctuations less than 1%. When coupled with a 7-cm × 7-cm large multiple-aperture extractor, this system has produced a deuterium ion beam of about 15 A with 20-keV energy. (auth)

4267 (LBL-916) PRODUCTION OF INTENSE ION AND NEUTRAL BEAMS WITH A MULTIPLE-SLOT, LARGE-AREA EXTRACTOR. Cooper, W. S.; Berkner, K. H.; Pyle, R. V. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1972. Contract W-7405-eng-48. 6p. (CONF-720948-9). Dep. NTIS.

From second international conference on ion sources; Vienna, Austria (11 Sep 1972).

The extractor was designed with the aid of a digital computer program which determines the trajectories of particles from an emitting surface through a set of electrodes, taking into account the space charge of the beam. The extractor is a multiple-aperature accel-decel design employing slots. There are 21 slots in the beam-forming electrode, each 2 mm wide and 7 cm long, spaced 3.3 mm center-to-center, filling a square array 7 cm on a side. The plasma source consisted of a hot cathode discharge between a circular row of 20 hairpin-shaped tungsten filaments and a concentric outer anode. The high voltage for ion extraction and acceleration is provided by a pulse line with a pulse length of 20 msec. The line feeds a vacuum tube which acts both as a voltage regulator and a series switch to remove the voltage quickly from the extractor and prevent damage if a spark is detected by a current monitor. The performance of this system is described. (M.O.W.)

4268 (MATT-922) NEUTRON-PLASMA INTERACTION IN FUSION REACTORS: EVALUATION OF POSSIBILITIES AND IMPLICATIONS. Greenspan, E. (Princeton Univ., N. J. Plasma Physics Lab.). Sep 1972. Contract AT(11-1)-3073. 35p. Dep. NTIS.

The possibilities for direct neutron-plasma interaction to have practical effects on the performance of fusion reactors are investigated. The implications such interactions, if occurring, will have on the plasma energy balance, particle balance, and fusion probability are studied. The dependence of neutron-plasma interaction probabilities on fusion-reactor blanket composition, plasma composition, temperature, density, and radius is also investigated. The probability that the tritons produced will undergo a D-T reaction in the process of their slowing down is calculated. A new scheme for fission-fusion reactor symbiosis is evaluated. The scheme consists of non-self-sustained (subcritical) fission and fusion reactors that become critical via the neutron-plasma direct interaction. It is concluded that, unless present values of plasma pressure times radius are increased by at least 10^2, the direct coupling between the fission and fusion reactors will be too weak to have any advantages. (auth)

4269 (TID-26195) FUSION AND NATIONAL ENERGY. Fraas, A. P. (Oak Ridge National Lab., Tenn.). 1972. 23p. Dep. NTIS.

The following topics are discussed: (1) energy requirements, (2) energy supplies, (3) reference design for a fusion power plant, (4) fusion reactor fuel supply, and (5) ultimate systems. (M.O.W.)

4270 LASER INDUCED THERMONUCLEAR FUSION DEVICE. Bobin, J.-L.; Tonon, G. (to Commissariat a l'Energie

Atomique). French Patent 2,112,057. 16 Jun 1972. Filed 19 Aug 1970. (In French).

A device utilizing a laser to induce thermonuclear fusion is described. A laser beam having sufficient energy interacts with a solid target to produce a plasma in which thermonuclear reactions can take place. (France)

4271 THERMONUCLEAR FUSION REACTORS: PRESENT STATUS AND PROSPECTS. Schmitter, K. H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Atomwirt., Atomtech.; 17: No. 11, 565-70(Nov 1972). (In German).

Nuclear fusion reactors are discussed with respect to fuel selection, minimum requirements for plasma, and methods for plasma containment and heating. The present status of fusion research is surveyed together with technical problems such as vacuum wall, blanket, magnetic field, and fuel supply. The scheme of a fusion power plant is depicted in a diagram. Further steps toward development of fusion reactors are outlined. Fusion power plants are discussed from the standpoint of economy and environmental impact. (H.B.G.)

4272 CALCULATION OF SELF-INDUCTANCES OF THICK AIR-CORE COILS, MUTUAL INDUCTANCES, AND AXIAL FORCES BETWEEN SUCH COILS IN COAXIAL SYSTEMS BY MEANS OF A DIGITAL COMPUTER. Poehlchen, R. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). pp 142-56 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The magnetic flux of a semi-infinite circular current sheet (ideal solenoid) can be described with the "general complete elliptic integral." From the expression for the magnetic flux of an ideal solenoid, formulas for the axial forces and mutual inductances between two ideal solenoids in coaxial geometry can be derived. Thick-walled solenoids are computed by dividing each solenoid into a number of current sheets and adding the contributions of each individual current sheet according to a "composite Gaussian quadrature" formula. A program was written for computing all inductances and axial forces for an arbitrary number of thick coaxial coils. The only input data which are needed for the calculation are the geometrical dimensions of the coil system, the current densities, the winding densities, and the number of abscissas. The accuracy of the results depends on the number of abscissas. (auth)

4273 SUPERCONDUCTING LEVITRON. Cornish, D. N. (Culham Lab., Abingdon, Eng.). pp 847-54 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

A brief discussion is given of the cryogenic and superconducting aspects of the levitron device being built at Culham Laboratory. (M.O.W.)

4274 LARGE SUPERCONDUCTING COILS FOR A STELLERATOR EXPERIMENT. Oswald, B. (Institut fuer Plasmaphysik GmbH, Garching Ger.). pp 855-68 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The development of large superconducting coils for the main field of future W stellarators is briefly discussed. Magnetic forces and protection system requirements are also mentioned. (M.O.W.)

4275 PRODUCTION OF PULSED HIGH MAGNETIC FIELDS WITH ROTATING MACHINE. Rebut, P. H. (EURATOM-CEA, Fontenay-aux-Roses, France); Torossian, A.; Gauchon, G.; Delassus, J.; Le Henaff, J. pp 1278-92 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

Two kinds of rotating machines are briefly discussed: (1) the "pulsatrices" in which the rise time of the fields is about 15 msec and the magnetic energy 60 MJ, and (2) a power source including alternator–flywheel rectifier, for the study of tokamaks. (M.O.W.)

4276 DESIGN AND REALISATION OF 100-MJ PULSED UNIPOLAR GENERATOR. Chaboseau, N.; Guillet, R.; Lucidarme, J.; Rioux, C. pp 1305-12 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

A system consisting of a generator coupled to a flywheel is described. The operation, technical characteristics, and predicted performance of the machine are briefly described. (M.O.W.)

4277 TOROIDAL HIGH FIELD COIL FOR THE ALCATOR EXPERIMENT. Leupold, M. J.; Montgomery, D. B.; Weggel, C.; Weggel, R. J. (Massachusetts Inst. of Tech., Cambridge). pp 1543-4 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

The toroidal field coil surrounds a plasma chamber 108 cm in major diameter and 26 cm in minor diameter. The minor diameter of the coil itself is 32.5 cm. The central field will be a nominal 120 kG and the mean current density at the bore of the coil, 21,000 A/cm^2. The experiment is briefly described. (M.O.W.)

4278 NUCLEAR FUSION REACTORS. Mori, Shigeru (Japan Atomic Energy Research Inst., Tokai). Nippon Butsuri Gakkaishi; 27: No. 1, 20-9(Jan 1972). (In Japanese).

Nuclear fusion is reviewed from the technical viewpoint of reactors. The fusion reactors will become the main power supplier early in the next century. Environmental problems of energy generation and associated economical problems will motivate their development. The physical background of fusion reactors, i.e., fundamental reaction and their cross section, equations for the balance of plasma density and energy, Lawson's criterion, etc., are explained. Various systems for plasma confinement are reviewed and discussed from the viewpoint of engineering practicability. The most promising one seems to be the tokamak-type. Finally, scope and structure of the fusion reactors are explained as well as the many unsolved technical problems. Developmental study will change from physical to technical in the coming years. (Japan)

4279 STEADY TOKAMAKS WITH RELATIVISTIC ELECTRONS. Ikuta, Kazunari (Nagoya Univ., Japan). Jap. J. Appl. Phys.; 11: No. 11, 1684-5(Nov 1972).

A simple method of maintaining a toroidal current in resistive plasmas is proposed. A high-current relativistic electron ring, with its major radius approximately equal to that of the toroidal plasma, and a low-intensity ion beam are injected into the plasma. The resultant increase in the plasma current compensates for the decay of the current due to the plasma resistivity. It turns out that the ion beam current required may be much smaller than that of the electron ring. (auth)

Wave Phenomena

4280 (AEC-tr-7346) TRANSFORMATION OF ELECTROMAGNETIC WAVES INTO LONGITUDINAL OSCILLATIONS IN A NONHOMOGENEOUS PLASMA IN THE PRESENCE OF PERFECTLY CONDUCTING SURFACE. Demchenko, V. V.; Dolgopolov, V. V.; Omel'chenko, A. Ya. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated from report KHFTI-70-54. 15p. Dep. NTIS.

It is shown that the electromagnetic waves caused by initial perturbation on the boundary of a semi-infinite plasma in the presence of a perfectly conducting surface, during the time determined by the width of the transition zone between the plasma and vacuum, are converted to longitudinal oscillations concentrated in the transition layer between the plasma and vacuum and propagating along the plasma density gradient. (auth)

4281 (AEC-tr-7355) THEORY OF WAVE INTERACTIONS IN THE BEAM–PLASMA SYSTEMS IN MAGNETIC FIELDS. Korsunskii, A. M.; Repalov, N. S.; Khizhnyak, N. A. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated from report KHFTI-70-75. 11p. Dep. NTIS.

The plasma–electron beam system can be used in devices intended for creating intensive waves of a space charge which, in turn, can be used for accelerating ions. The process of ion acceleration imposes rigid requirements on the form of the accelerating fields. Therefore, the problems of the stability of the spectrum of these fields are extremely important. A nonlinear region of plasma oscillations with an electron beam placed in a uniform magnetic field was investigated in this work. Regions of stable and unstable regimes were found, and the dynamics of energy exchange between individual waves was studied. (auth)

4282 (CEA-R-4351) INFLUENCE OF COLLISIONS ON THE INCOHERENT SCATTERING SPECTRUM OF A NON-EQUILIBRIUM INHOMOGENEOUS ABSORBING PLASMA. Meyer, Bernard (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Aug 1972. 36p. (In French). Dep. NTIS (U. S. Sales Only).

The study starts from P. Waldteufel's theory which deals with the effect of collisions on the scattering of an electromagnetic wave in a partially ionized gas. It is applied to fully ionized

plasmas, taking into account different kinds of collisions between charged particles. A method is given for numerical resolution of the plasma dispersion function, and results are deduced from final Waldteufel's equations when counterstreaming ions and electrons with various temperature ratios are assumed. Diffusion spectra are obtained for dense, inhomogeneous, absorbing, and even out-of-equilibrium plasmas, such as laser-created plasmas. The influence of collisions in terms of observation angle and drift velocity is studied. (auth)

4283 (NP-19588) AMPLITUDE OF SPATIAL ELECTRON PLASMA WAVE ECHOES. Matthieussent, Gilles (Paris Univ. (Francep). Laboratoire de Physique des Plasmas). 1972. 199p. (In French). (LP-139). Dep. NTIS (U. S. Sales Only).

The amplitude of spatial plasma wave echoes was studied as a function of the amplitude of the primary waves and the distance between the emitters. Saturation effects as well as the dissymmetric role played by the emitters were observed. The experimental results are in agreement with a nonlinear theory taking into account the self-consistent fields and the finite transit time of the particles. Injection of broad-band high-frequency noise in the plasma reduces the amplitude of the echoes, which is in agreement with a theory considering diffusion in velocity space. (France)

4284 HYDRODYNAMIC EFFECTS IN A NONIDEAL PLASMA. Fortov, V. E. (Moscow Physical-Technical Inst.). High Temp. (USSR) (Engl. Transl.); 10: No. 1, 141-53(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 168-80 (1972).

Possible hydrodynamic effects with a shock wave and with isentropic compression or expansion of a medium with anomalous thermodynamic properties, due to strong interparticle reactions in a plasma are discussed. On the basis of thermodynamic relationships, types of phase transitions are described which can be recorded using shock adiabatic curves and isentropes. Using the criterion for the stability of the front of a shock wave, for a cesium plasma a calculation is made for the region of parameters corresponding to the spontaneous emission of sound by the front of a shock wave; the article gives the parameters of a cesium shock tube, permitting the experimental achievement of any given conditions for instability. Questions connected with the nonsingular nature of the representation of thermodynamic states in certain variables are evaluated. (auth)

4285 WAVES BENDING AROUND ELECTRON FLUXES. Gladun, A. D.; Korshunov, S. M. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 16-23(1972). (In Russian).

The behavior of waves in bending around in a nonrelativistic electron flux in an immobile ionic background was studied. The velocity of a stationary wave in bending is always equal to the velocity of an undisturbed electron flux. A given disturbance in the bending is propagated at the speed of an undisturbed flux. The result of the argument is of interest to the theory of nonlinear waves in dispersion media. (tr-auth)

4286 LOW-FREQUENCY OSCILLATIONS OF A RING DISCHARGE PLASMA IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Andropov, V. G.; Kruzhilin, N. A.; Lopatskii, G. S.; Petrov, G. D. Zh. Prikl. Mekh. Tekh. Fiz.; No. 3, 171-3(1972). (In Russian).

Low-frequency oscillations were studied in a ring discharge plasma. Values of the magnetic field that correspond to the incipient formation and collapse of the ionizing oscillations were found. An analysis was conducted for the plasma stability in the absence of an ionization equilibrium. Agreement between theoretical and experimental results was evident. (K.S.W.)

4287 INCOHERENT SCATTERING OF LIGHT FROM CHARGE-DENSITY FLUCTUATIONS IN WEAKLY IONIZED MAGNETOPLASMAS. Klingenberg, G.; Richter, E. W. (Technische Univ., Brunswick). Z. Naturforsch.; 27a: No. 8-9, 1374-5(1972). (In German).

The spectral density of light scattering from weakly ionized plasmas embedded in a homogeneous magnetic field B is given by the work of Williams and Chappell and Klingenberg. The spectral density is computed for electron plasmas and is analyzed for the case $k \perp B$ (k is the difference between the wave vectors of the incident wave and the scattered wave) in the regimes $kD \gg 1$ and $kD \ll 1$ (D is the Debye length). (auth)

4288 DRUDE THEORY OF ELECTROMAGNETIC WAVES IN AN INCLINED MAGNETIC FIELD. I. ONE-BAND MODEL OF CHARGE CARRIERS. Halevi, P. (McGill Univ., Montreal). Can. J. Phys.; 50: No. 14, 1600-8(15 Jul 1972).

Magnetoplasma waves propagating at an angle to a static magnetic field are investigated for an isotropic system of carriers. The dispersion relations and polarizations are presented in graphical form, and useful expressions are derived for limiting cases. The longitudinal and transverse modes interact, leading to coupled modes in the vicinity of the plasma frequency. Damping and nonlocal effects are also discussed. (auth)

4289 RESONANCE COUPLING OF A TRANSVERSE MAGNETIC RESPONSE TO A TRANSVERSE ELECTRIC EXCITATION BY THE AXIAL DENSITY GRADIENT OF A BOUNDED PLASMA. Faulconer, D. W.; Messiaen, A. M.; Vandenplas, P. E. (Ecole Royale Militaire, Brussels). Phys. Lett.; 41A: No. 5, 467-8(23 Oct 1972).

The transverse electric to transverse magnetic partial transformation in polarization of an incident transverse electric wave due to the axial density gradient of a plasma column is studied. This transformation is shown to be particularly strong at main resonance. (auth)

4290 SECOND-HARMONIC GENERATION AT THE UPPER HYBRID LAYER IN THE ST TOKAMAK. Cano, R.; Etievant, C.; Hosea, J. (Princeton Univ., N. J.). Phys. Rev. Lett.; 29: No. 19, 1302-5(6 Nov 1972).

An extraordinary incident wave, propagating along the major radius through the ST Tokamak plasma, is used to generate a second-harmonic wave inside the plasma. The detected harmonic-power characteristic agrees well with that predicted by the theory for local harmonic generation in the upper hybrid layer. The detected harmonic wave is essentially extraordinary, but has a small ellipticity. (auth)

4291 RECURRENCE OF NONLINEAR ION ACOUSTIC WAVES. Tappert, F. D.; Judice, C. N. (Bell Lab., Whippany, N. J.). Phys. Rev. Lett.; 29: No. 19, 1308-11(6 Nov 1972).

The recurrence time of ion acoustic waves in a plasma was obtained, as a function of the parameters describing the plasma, on the basis of the Korteweg-de Vries (KdV) equation and Whitham's extended KdV equation. Direct numerical solutions of the ionic Vlasov equation were also obtained that quantitatively confirm the predictions of the KdV equation. (auth)

4292 NONLINEAR MODE COUPLING AND RELAXATION OSCILLATIONS. White, R. B.; Lee, Y. C.; Nishikawa, Kyoji (Univ. of California, Los Angeles). Phys. Rev. Lett.; 29: No. 19, 1315-18(6 Nov 1972).

By means of simple model equations the mode coupling between linearly unstable and stable waves is investigated. A sharp relaxation oscillation, damped either in the presence of spontaneous emission, or by a quasilinear reduction of the growth rate, is found. Effects of external modulation of the growth rate are investigated. The final saturation level exhibits two-threshold behavior as a function of the growth rate. (auth)

4293 DYNAMICS OF THE FREQUENCY SPECTRUM OF OSCILLATIONS EXCITED IN A PLASMA-BEAM DISCHARGE. Zeidlits, V. P.; Berezin, A. K. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 8, 1366-9(Aug 1972). (In Russian).

The energy spectrum of oscillations excited in an intense plasma-beam discharge was investigated. Langmuir oscillations were analyzed in order to illustrate a method of determination of the time behavior of the frequency spectra. (K.S.W.)

PHYSICS (RADIATION AND SHIELDING)

Radiation Physics

Refer also to abstracts 3513, 3514, and 3534.

4294 (ANL-7960(Pt.1)) RADIOLOGICAL AND ENVIRONMENTAL RESEARCH DIVISION. ANNUAL REPORT ON RADIATION PHYSICS, JULY 1971–JUNE 1972. (Argonne National Lab., Ill.). 1972. Contract W-31-109-eng-38. 135p. Dep. NTIS.

Most of the information reported here results from three programs, namely: (1) electron scattering, (2) photoionization, and (3) theoretical studies. Much of the information is in the form of abstracts of published or to-be-published papers. "Out-of-scope" studies with no indication of publication include the following: (1) absorption cross sections for acetone, acetaldehyde, methyl acetate, and nitric oxide in the euv region, (2) development of a hollow cathode lamp for He I(584 Å) and He II(304 Å) radiation, and (3) angular distribution of photoelectrons in multiphoton ionization of atoms. Separate abstracts were prepared for three items in scope for NSA. (L.M.T.)

For abstracts of individual sections see: 3513, 3514, and 3534.

4295 (LCA-NT-177-E-T) APPLICATION OF THE REGULATION METHOD IN DOSIMETRY. Fiegel, Arsene (Laboratoire Central de l'Armement, Arcueil (France)). 15 Sep 1971. 40p. (In French). Dep. NTIS (U. S. Sales Only).

The Tikhonov or regularization method is recalled and it is shown how the introduction of Euler–Lagrange equations leads to a tenfold reduction in the computation time. This method is used to obtain information from dosimeter films; the assumption that a point on the response curve is known being made. This supplementary information is introduced using a Lagrange parameter. (France)

4296 (SC-RR-720659) ANALYTICAL APPROXIMATIONS FOR PHOTON–ATOM DIFFERENTIAL SCATTERING CROSS SECTIONS INCLUDING ELECTRON BINDING EFFECTS. Biggs, Frank; Lighthill, Ruth (Sandia Labs., Albuquerque, N. Mex.). Oct 1972. 66p. Dep. NTIS.

Analytical approximations convenient for computer use are described for both coherent and incoherent photon–atom differential scattering cross sections. The effects of electron binding are taken into account by applying multiplicative factors to the corresponding free electron cross sections. These approximations have the property that the same simple analytical form is preserved in cases where an average effective cross section is constructed for a composite material consisting of several elements. The elements of atomic numbers $1 \leq Z \leq 100$ are included in the approximation scheme. (auth)

4297 MEASUREMENT OF STOPPING POWERS FOR ^{4}He, ^{16}O, AND ^{35}Cl IONS AT ~1 TO ~3 MeV PER NUCLEON IN Ni, Ge, Y, Ag, AND Au. Ward, D.; Graham, R. L.; Geiger, J. S. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 50: No. 19, 2302-12(1 Oct 1972).

Stopping powers were measured for ^{4}He, ^{16}O, and ^{35}Cl ions at energies of ~1 to ~3 MeV per nucleon in Ni, Ge, Y, Ag, and Au foils. The absolute accuracy is of the order of ±4%. The results are compared with the semiempirical values tabulated by Northcliffe and Schilling and with previous experimental values. (auth)

4298 INVARIANT IMBEDDING AND RADIATION DOSIMETRY. II. INTEGRAL RECURRENCE RELATIONS FOR THE FINITE ORDER SCATTERING AND TRANSMISSION FUNCTIONS. Bellman, R.; Ueno, S.; Vasudevan, R. (Univ. of Southern California, Los Angeles). Math. Biosci.; 15: No. 1-2, 153-62(Oct 1972).

In radiation dosimetry problems the computation of the reflection and transmission function is important for guidance in determining the amount of dosage received by the irradiated parts of the body of material involved. An easy method of obtaining numerical results is outlined. In radiation shielding and other situations where the bounding surfaces are metals, transfer of radiation in a semi-infinite slab is encountered. This problem is analyzed with a veiw to obtaining numerical results in an easy manner. (auth)

4299 L-SHELL PHOTOELECTRIC CROSS SECTIONS OF GAMMA RAYS IN Cd. Ramana Rao, P. V.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Indian J. Phys.; 46: No. 1, 44-5 (Jan 1972).

L-shell photoelectric cross sections in Cd at 84 to 145 keV are estimated and compared with theoretical values of Schmickley & Pratt (NSA 21:37097). The required gamma sources for the energies 84, 100, 129, and 145 keV are obtained from the BARC, Bombay. The calculated values at these energies are compared with the theoretical values and presented in a table in barns per atom. (J.C.W.)

4300 TRANSITION RADIATION FROM A PLASMA BOUNDARY. Seshadri, S. R. (Univ. of Wisconsin, Madison). Can. J. Phys.; 50: No. 19, 2244-52(1 Oct 1972).

The transition radiation emitted by a point charge moving with a uniform velocity across a plane interface separating a half-space of plasma from another half-space of free space is investigated. The transition radiation is partly in the form of space waves and partly in the form of surface waves. The characteristics of these waves are discussed with the help of some typical numerical results. The surface-wave power is shown to be many orders larger than the space-wave power and near the surface-wave resonant frequency an increase in the particle velocity is found to decrease the surface-wave power. (auth)

4301 CHARACTERISTIC ENERGY LOSSES BY SLOW ELECTRONS IN THIN FILMS OF ALKALI HALIDES. Hiraoka, Kenzo; Hamill, W. H. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 57: No. 9, 3881-7(1 Nov 1972).

The potassium halides and the alkali metal iodides were examined by electron impact in the range 0 to 50 eV. Both electron transmission and backscattering currents (I_t, I_b) were measured while sweeping the modulated accelerating or retarding potentials (V_i, V_r). The characteristic energy-loss spectra are presented as dI_t/dV_i vs V_i or dI_b/dV_r vs V_r. The principal events, in order of increasing V_i or decreasing V_r, are: electron trapping by cations to ns ^{2}S and np ^{2}P alkalis, and possibly higher; usually three resonances attributed to low-lying states of halide ions, possibly $^{3}P_{2,1,0}$ among others (triplet exciton); the fundamental singlet exciton; the vacuum level; the higher fundamental singlet exciton and vacuum level involving halogen ns ^{4}P. The crystal electron affinities were evaluated by two methods. (auth)

4302 CHARACTERISTIC ENERGY LOSSES BY SLOW ELECTRONS IN ORGANIC MOLECULAR THIN FILMS AT 77°K. Hiraoka, Kenzo; Hamill, W. H. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 57: No. 9, 3870-81(1 Nov 1972).

Characteristic energy losses by slow electron impact were measured for $\leq 10^{2}$-Å films of several aromatic compounds as well as alkanes, alkenes, alcohols, acetone, and ice at 77°K. Resonances are clearly indicated by the electron current I transmitted by the dielectric as a function of the modulated thermionic emitter voltage V, displayed as dI/dV vs V. Energy losses are measured directly by retarding potential analysis of backscattered electrons. Measurements at several incident electron energies provide the V dependence of the cross section. The method is particularly useful for measuring small losses (~1 eV). There is no potential barrier for injecting electrons into the dielectrics examined, and the evidence indicates that they have positive bulk electron affinities. All systems show resonances at 0.5 to 1 eV, which are attributed to transient negative ions. Acetone, n-hexane, and ice were examined in some detail for 0- to 4-eV losses by retarding potential analysis. The results indicate that electrons are also inelastically scattered by higher transient negative-ion states. All compounds examined show resonances in the 3- to 4-eV range, which may be due to low-lying triplet states. The alkanes also have considerable oscillator strength in the 4- to 7-eV range, approximating that in the 7- to 10-eV range. (auth)

4303 LUMINESCENCE EXCITATION AND CHARACTERISTIC ENERGY LOSSES BY SLOW-ELECTRON IMPACT ON KI AND KCl–KI THIN FILMS. Hiraoka, Kenzo; Hamill, W. H. (Univ. of Notre Dame, Ind.). J. Chem. Phys.; 57: No. 9, 4058-9 (1 Nov 1972).

Characteristic energy-loss spectra and luminescence-excitation spectra for low-energy electrons (2 to 14 eV) in films of KI and 0.1% KI in KCl are reported briefly. They show that low-energy emissions can be correlated with optically forbidden low-energy excitations. (A.G.W.)

4304 PHOTOIONIZATION OF N_2, O_2, NO, CO, AND CO_2 BY SOFT X RAYS. Van Brunt, R. J.; Powell, F. W.; Hirsch, R. G.; Whitehead, W. D. (Univ. of Virginia, Charlottesville). J. Chem. Phys.; 57: No. 8, 3120-9(15 Oct 1972).

The total and relative abundances of thermal-energy ions produced by absorption of 0.28-, 1.25-, and 1.5-keV x rays in N_2, O_2, NO, CO, and CO_2 and the dissociative ionization cross sections at these energies were measured using a mass-spectro-

metric technique. The results demonstrate that there is a significant change in the character of the ionization at the K-absorption edges of the atomic constituents. At these energies dissociative ionization predominates for all the molecules, accounting for over 95% of the ions formed at energies above the K edge. Quasi-stable doubly charged molecular ions make a significant contribution to the thermal-energy ions at energies above the K edge. The results for the total abundances of thermal singly and doubly charged molecular ions are compared with recent measurements by Carlson and Krause. (auth)

4305 X-RAY THERAPY PLANNING IN THREE DIMENSIONS BY COMPUTER. Worthley, B. W.; Nicholls, R. L. (Univ. of Adelaide). Australas. Radiol.; 15: No. 4, 372-81 (Nov 1971).

The problem of dosage calculation at a point within a patient irradiated by a beam of x rays may be resolved into four parts: (1) geometrical description of body surfaces (both external and internal) and the physical densities of various tissues contained by these surfaces; (2) description of the x-ray beam in terms of (a) its geometrical properties, i.e., field outline, divergency angles, S.S.D., angles of incidence, etc., and (b) beam modifying factor, e.g., wedge and compensating filters; (3) geometrical relationships between the patient and the beam of radiation; and (4) nature of the interaction of the radiation with the various body tissues, i.e., depth dose considerations. A great deal of the computation involved in determining dosage at a point within a patient resolves itself into three-dimensional coordinate geometry and, while this is not difficult, the arithmetic involved is extremely tedious and for a complex treatment plan too time-consuming for manual evaluation. In a practical sense such calculations are possible only with the assistance of a high-speed digital electronic computer. A Fortran IV program was therefore devised to make dosage calculation in three dimensions a useful and feasible proposition. (auth)

4306 SCREENING EFFECTS IN ATOMIC PAIR PRODUCTION BELOW 5 MeV. Tseng, H. K.; Pratt, R. H. (Univ. of Pittsburgh). Phys. Rev., A.; 6: No. 6, 2049-56(Dec 1972).

Quantitative predictions for atomic-electron screening effects in low-energy pair production follow from the knowledge that the small-distance shape of screened-electron and positron continuum wave functions is close to that of point-Coulomb wave functions of shifted energy. These predictions are verified by making exact numerical calculations in representative cases. The energy-shift normalization theory is then used in conjunction with the point-Coulomb results of Øverbø to obtain predictions for atomic-pair-production energy distributions and total cross sections for photon energies from threshold to 5 MeV. Atomic-electron screening effects cause appreciable modifications of the total cross sections for photon energies below 1.5 MeV and continue to have a major effect on some portions of the energy distribution at higher photon energies. Results are also compared with Bethe–Heitler predictions and with experiments. (auth)

4307 DETERMINATION OF MASS-ATTENUATION COEFFICIENTS IN KRYPTON AND XENON BY CONTINUOUS ANALYSIS BETWEEN 8 AND 0.8 keV. Wuillemier, Francois (Faculte des Sciences, Paris). Phys. Rev., A.; 6: No. 6, 2067-77(Dec 1972).

The bremsstrahlung emitted from a tungsten anode in an x-ray tube was used for continuous analysis of krypton and xenon absorption spectra between 8 and 0.8 keV (1.5 to 15 Å). Attenuation coefficients were determined every 0.05 Å between 1.5 and 8 Å (in steps of energy varying from 150 to 10 eV) and every 0.1 Å between 8 and 15 Å (20 to 5 eV). Results obtained are compared with previously determined experimental values and with semi-empirical and theoretical determinations. Tabulated data of McMaster et al. and calculations of McGuire are shown to be in good agreement with the experimental results, generally within 10%. Multiply excited and ionized states were observed in krypton, owing to simultaneous interaction of incident radiation with 2p and 4p (and 4s) electrons, and a nonhydrogenic behavior of the xenon 3p-subshell photoionization cross section was revealed. Krypton and xenon L and xenon M_{III} absorption jump ratios were determined. Finally, continuous oscillator strengths of krypton and xenon L shells and xenon M shell were evaluated. (auth)

Radiation Source Calibration and Standardization

4308 INTEGRITY STANDARDS AND TEST SPECIFICATIONS FOR SELECTED BRACHYTHERAPY SOURCES. ANSI N44.1-1972. Rockville, Md.; Bureau of Radiological Health (1972). 6p.

This standard establishes the integrity requirements and test specifications for selected, sealed brachytherapy sources. The particular standards and specifications required are those that are appropriate to the various types of sources being considered. The standard does not attempt to establish design requirements but rather establishes performance standards for the particular sources involved, such that any sources that pass these tests shall be expected to be acceptable for use in brachytherapy. (auth)

4309 LEAK TESTING RADIOACTIVE BRACHYTHERAPY SOURCES. ANSI N44.2-1972. Rockville, Md.; Bureau of Radiological Health (1972). 11p.

This standard provides guidelines for testing the leakage of sealed, radioactive brachytherapy sources. Seal integrity of these sources shall be maintained (1) to prevent loss of radioactive material and thus assure effective radiation output, (2) prevent unnecessary radiation exposure and contamination of patients and medical personnel, and (3) prevent local or widespread radioactive contamination and the resultant costly decontamination operations and liability damage. (auth)

PHYSICS (SOLID-STATE)

Radiation Effects

Refer also to abstracts 2573, 4301, and 4303.

4310 (KFK–1652) POINT DEFECTS AND HOLE FORMATION: USEFUL EXTENSIONS. Kaletta, D.; Schneider, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Jul 1972. 59p. (In German). Dep. NTIS (U. S. Sales Only).

This paper consists of two parts. The first one treats the nuclear interaction between target atoms and bombarding particles, investigating the damage due to the collision events, such as atomic displacements and production of displacement cascades. Diffusion-controlled phenomena are excluded. The interaction energy ranges from several keV up to several MeV. Collision partners are medium and heavy ions in metals. The second part discusses the thermodynamic behavior of the defects under steady-state conditions. The effects building up voids are treated as nucleation and growth processes in classical manner. Several models are sketched, leading to computer simulations, which show a good agreement between the theories and the behavior observed in irradiated materials. (auth)

4311 DIMENSIONAL EXPANSION AND SURFACE MICROSTRUCTURE IN HELIUM-IMPLANTED ERBIUM AND ERBIUM-HYDRIDE FILMS. Blewer, R. S.; Maurin, J. K. (Sandia Labs., Albuquerque, N. Mex.). J. Nucl. Mater.; 44: No. 3, 260-78(Sep 1972).

Topographical, subsurface, and expansion phenomena on helium-implanted erbium and erbium-deuteride films were investigated, using scanning electron microscopy, double-beam interferometry, light optical microscopy, and surface microprofiling techniques. The thickness of helium-implanted erbium films was observed to increase linearly with dose up to 3×10^{17} He^+/cm^2 (at 160 keV), and to exhibit a superlinear dependence at higher doses. Striking microscopic surface features were observed on the implanted erbium and erbium-deuteride films; their onset is dependent on dose and the temperature of post-implantation anneal. Release of helium from the films occurs predominantly by bubble rupture at the film surface rather than by volume or grain boundary diffusion. Examples of preferred nucleation of surface bubbles at sites of film irregularities and defects are noted. Surface features occurring in implanted erbium-deuteride and aged erbium-tritide films are compared and are found to bear a strong resemblance to each other. (auth)

4312 EFFECT OF REACTOR IRRADIATION ON THE OPTICAL TRANSITIONS IN Ge, GaAs, AND Se. Tuomi, T. O.; Tiainen, O. J. A.; Stubb, T. (Univ. of Helsinki). Solid State Commun.; 11: No. 8, 1039-41(15 Oct 1972).

The effect of reactor irradiation on the wavelength-modulated reflectance and the electroreflectance of monocrystalline Ge, GaAs, and Se was studied. The temperature during irradiation was 300 to 310°K. The changes in the reflectance peak positions caused by irradiation were measured. (auth)

4313 ENERGY SPECTRUM OF RADIATION DEFECTS IN p-TYPE SILICON IRRADIATED BY PROTONS. Isaev, N. U.; Mukashev, B. N.; Karsybaev, M. Sh. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 6, 46-9(1971). (In Russian).

An analysis was made of the data on the temperature dependence of the Hall effect in the region 78 to 350°K and of the isochronous annealing curves in the 350 to 900°K range. It was concluded that, in p-type silicon alloyed with phosphorus and irradiated with 10-MeV protons, three types of defects are introduced: A centers, E centers, and divacancies. The depth of deposition of energy levels for E centers and divacancies coincide and are located near $E_c - 0.4$ eV. The identification of E centers and divacancies was made by measuring the temperature dependence of the Hall effect during various stages of isochronous annealing. With increase in the integral dose, the concentration of divacancies grew. A stage of "negative" annealing was detected that was associated with increased concentration of A centers as a result of divacancy decay. (tr-auth)

4314 KINETICS OF THE Z_1 GENERATION IN X-RAYED NaCl:Sr^{+2}. Kristianpoller, N.; Katz, I. (Tel Aviv Univ., Israel). Solid State Commun.; 11: No. 8, 1057-61(15 Oct 1972).

The generation of the Z_1 centers in x-ray-colored NaCl : Sr^{+2} was investigated. The Z_1 band was resolved from the absorption envelope by a numerical method. The changes in the various absorption bands were measured as a function of the time of the F bleaching. Some differences were noticed in the behavior of NaCl : Sr^{+2} compared to that of KCl : Sr^{+2}. In spite of these differences, the experimental results of NaCl were found to fit the model and the kinetic equations for the F to Z_1 transition which have previously been developed for the case of KCl. Parameters for the probability of an electronic and an ionic process were computed from the best fit. The results proved that in NaCl as in KCl, the generation of the Z_1 centers is controlled by the ionic diffusion. (auth)

4315 ELECTRICAL RESISTIVITY OF SOME LATTICE DEFECTS IN FCC METALS OBSERVED IN RADIATION DAMAGE EXPERIMENTS. Martin, J. W. (Technical Univ. of Denmark, Lyngby). J. Phys., F (London); 2: No. 5, 842-53(Sep 1972).

The electrical resistivity of 44 point defects, which occur in the annealing stages of fcc metals, are calculated using the real space formulation of the pseudopotential theory of resistivity recently derived by the author (Martin, Phil. Mag., 24: 555-66(1971)). The structures of the stable defects produced by irradiation have been taken from previous atomistic calculations and used in calculating the resistivities of various forms of the vacancy complex, Frenkel defect, and interstitial. Special attention is paid to the effect of the relaxation of atoms around these defects and in the case of interstitials it is shown that a large fraction of the resistivity is caused by such relaxations. (auth)

4316 ENTRAPMENT AND THERMAL EVOLUTION OF LOW ENERGY INERT GAS IONS INJECTED INTO BOROSILICATE GLASS. Cavaleru, A. O. R.; Armour, D. G.; Carter, G. (Univ. of Salford, Eng.). Vacuum; 22: No. 8, 321-5(Aug 1972).

Low-energy (100 to 1750-eV) Ar^+ and Kr^+ ions were injected into borosilicate glass targets from a monoenergetic ion source contained within an ultrahigh vacuum system. The entrapped gas was released from the glass target by heating in a controlled manner so that target temperature varied as a prescribed time function and the evolved gas was recorded with a small mass spectrometer. Observations of the integrated rate of gas release allowed deduction of the probability of ion entrapment as a function of ion fluence and energy and measurements of the instantaneous gas evolution rate as a function of temperature allowed deduction of the energies required for gas atom mobility in the glass. Results are compared with earlier measurements using more poorly defined ion and target parameters and the depth and nature of trapping centres for ion retention in the glass are discussed. (auth)

4317 DOUBLE RESONANCE (NQR–ESR) IN AN IRRADIATED $NaClO_3$ CRYSTAL. Dimitropoulos, C. (CEN, Grenoble, France); Salvi, A.; Ayant, Y. Compt. Rend., Ser. B; 275: No. 3, 153-5(17 Jul 1972). (In French).

The magnetic dipole interaction between the nonpaired electron of a free radical and the chlorine nucleus was revealed with a double resonance method in an irradiated $NaClO_3$ monocrystal. Significant increase in the NQR signal can be achieved by saturating the electron transitions. (France)

4318 EMISSION SPECTRUM OF Yb^{3+} IN CADMIUM SULPHIDE. Bryant, F. J.; Goodwin, G. K.; Lowther, J. E. (Univ. of Hull, Eng.). J. Phys., C (London); 5: No. 18, 2669-76 (19 Sep 1972).

The cathodoluminescence emission spectrum of Yb^{3+} in cadmium sulphide at 10°K was studied before and after irradiation with electrons capable of producing atomic displacements. The spectrum was assigned to emission from Yb^{3+} on a weakly distorted tetrahedral site such as it would be if the Yb^{3+} were replacing a cadmium ion. Multiplets with the main groups of lines are believed to result from the influence of sulphur ions, possibly at nearby interstitial sites. Electron radiation damage above the threshold energy for sulphur displacement, and with the sample at a temperature (~320°K) at which the defects are sufficiently mobile, causes a redistribution of sulphur among the interstitial sites which changes the relative intensities of the rare earth emission lines. (auth)

4319 THERMOLUMINESCENCE OF COPPER ACTIVATED NaCl CRYSTALS. Murti, Y. V. G. S.; Murthy, K. R. N. (Indian Inst. of Tech., Madras). J. Phys., C (London); 5: No. 19, 2827-33(3 Oct 1972).

The thermoluminescence of x-ray-coloured NaCl and NaCl : Cu crystals is studied in the temperature range 300 to 510°K. Five glow peaks centered at 343, 363, 391, 420, and 445°K are recorded for a warming rate of 40°K min^{-1} and analysis indicates first-order kinetics with activation energies 1.05, 1.12, 1.21, 1.47, and 1.47 eV respectively. The 391 and 420°K peaks can be related to the presence of dissolved copper ions. The first (391°K) is ascribed to hole release from Cu^{2+} centers formed by irradiation while electron release from an F center neighboring a Cu^{2+} ion

is believed to cause the 420°K peak. It is suggested that the other peaks originate from F centers generated during the initial growth stages. (auth)

4320 ELECTRON SPIN RESONANCE OBSERVATIONS OF CHLORINE AND BROMINE ATOMS ISOLATED AT 22°K IN X-IRRADIATED ALKALI HALIDE–ALKALI BORATE GLASSES. Griscom, D. L. (Naval Research Lab., Washington, D. C.). Solid State Commun.; 11: No. 7, 899-902(1 Oct 1972).

Alkali halide–alkali borate glasses were x-irradiated at 22°K and the induced color centers studied by electron spin resonance (ESR) techniques at X-band frequencies (~9 GHz). The complex ESR spectra were analyzed as superpositions of spectra due to a number of previously elucidated species, plus two new centers which are demonstrated to be Cl^0 and Br^0 atoms isolated in the chloride- and bromide-containing glasses, respectively. (auth)

4321 ELECTRON SPIN RESONANCE OF THE $BrCl^- - V_k$ CENTRE. Hausmann, A.; Pomplun, H. (Technische Hochschule, Aachen). Solid State Commun.; 11: No. 7, 867-9(1 Oct 1972). (In German).

ESR studies show that after x-ray irradiation combined with proper thermal treatment, $BrCl^-$ molecule ions aligned along the six ⟨110⟩ directions are present in crystals of KCl doped with a small amount of KBr. Doping with ^{81}Br greatly simplifies the ESR spectrum. The parameters of the spin Hamiltonian were calculated by making use of a computer program. (auth)

4322 INFLUENCE OF HYDROSTATIC PRESSURE ON THE MICROSTRUCTURE OF LiF SINGLE CRYSTALS CONTAINING CAVITIES. Evans, R. A.; Redfern, B. A. W.; Wronski, A. S. (Univ. of Bradford, Eng.). J. Mater. Sci.; 7: No. 10, 1216-17(Oct 1972).

Single-crystal LiF was irradiated and annealed to produce voids. Examination of etched {100} faces following pressurization treatments in the range 1 to 15 kbar revealed well-defined dislocation arrays surrounding the voids. Preliminary results presented for compression testing of irradiated material, both unpressurized and pressurized, indicate that the pressure-induced dislocations suppress stage I of the stress–strain curve and raise the flow stress and work-hardening rate. (UK)

4323 PHOTOCONDUCTIVITY IN IRRADIATED DIAMOND. Farrer, R. G.; Vermeulen, L. A. (Univ. of the Witwatersrand, Johannesburg). J. Phys., C (London): 5: No. 19, 2762-8 (3 Oct 1972).

Measurements are reported of the photoconduction spectra of several electron-irradiated type Ia and type IIa diamonds in the neighborhood of the GR1 and ND1 absorption systems, and the absorption lines which have been labelled GR2 to GR8, R9, and R10. Minima occur in the photoconduction spectra at the positions of maxima in the GR1 absorption system. Sharp peaks which persist at temperatures down to 8°K are observed in the photoconduction spectra at the positions of maxima in the ND1 absorption system and the lines GR2, etc. Mechanisms which might give rise to these sharp photoconduction peaks are discussed. (auth)

4324 LATTICE LOCATIONS OF IMPLANTED IMPURITIES DERIVED FROM MOESSBAUER EFFECT MEASUREMENTS. De Waard, H. (Univ., Groningen, Netherlands). pp 123-42 of Moessbauer Spectroscopy and Its Applications. Vienna; International Atomic Energy Agency (1972).

From Panel on Moessbauer spectroscopy and its applications; Vienna, Austria; (24 May 1971). See STI/PUB-304; CONF-710561.

The method of ion implantation by isotope separator or by recoil after nuclear reactions or transmutations, used to introduce small quantities of impurities into a large variety of materials, is especially useful when other methods of introduction fail, e.g., when the solid solubility of the impurity element is very small. If the implanted impurities are radioactive, the emitted radiation may be used to study their hyperfine interactions. In this case only very low impurity concentrations are needed. The Moessbauer effect has proved a useful method for such studies. When energetic ions are stopped in a crystal lattice, numerous vacancies and interstitials are created. The hyperfine interaction of the implanted atoms and the Moessbauer recoilless fraction may depend sensitively on the presence of such defects. In metals a large part of the crystal damage caused by the implanted ions anneals rapidly at room temperature. A distinction is therefore made between measurements where the hyperfine interaction is determined before annealing (immediate decay experiments) and those where the implanted nuclei decay only after the host is annealed (delayed decay experiments). "Pure" substitutional implants without associated vacancies after annealing are obtained when the solid solubility of the impurity element is not too small. If the solubility is extremely small, as for instance, for noble gases in metals, no pure substitutional implants can be obtained. This situation has been found from Moessbauer effect measurements on $^{133}CsMe$, using ^{133}Xe sources implanted in various metals. For the case of $^{133}CsFe$ the Moessbauer spectrum can be decomposed into at least three components with different magnetic splittings, isomer shifts, and recoilless fractions. Apparently, there are at least three different lattice locations in this case, characterized by a different amount of space around the implanted atoms. Only about 30% of these atoms occupy pure substitutional sites. This percentage is strongly reduced by a heat treatment of the source. These findings are consistent with results of channeling experiments. (35 references) (auth)

4325 STUDIES ON BOMBARDMENT-INDUCED DISORDER. VI. BOMBARDMENT-INDUCED AMORPHIZATION IN WO_3 AND ITS USE IN DEDUCING MEAN DAMAGE RANGES. Lam, N. Q.; Kelly, R. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 50: No. 17, 1887-95(1 Sep 1972).

WO_3, an anisotropic oxide subject to bombardment-induced amorphization, has particular importance in that the depth of the amorphization (R_a) can be estimated with great accuracy. The procedure is based on preparing anodic WO_3, crystallizing it on its metal substrate at 350 or 450°C, bombarding it, and then making direct use of the brilliant interference colors. Only Kr impact was studied, the values of R_a being found to lie in the region of 50 to 390 Å for Kr energies of 4 to 35 keV. It is argued that such values of R_a can be used to deduce $\langle \chi_d \rangle$, the mean damage range. One postulates that the fraction of atoms initially displaced at R_a is unique but otherwise unspecified. This means that the quantity $\gamma \approx (Bt) \exp(-\xi^2/2)$, where Bt is the dose, ξ stands for $(\langle \chi_d \rangle / \mu_{2d}^{1/2})(R_a/\langle \chi_d \rangle - 1)$, and $\mu_{2d}^{1/2}$ is the mean damage straggling, should be invariant for a given bombardment energy. In solving this equation advantage can be taken of the fact that the ratio $\langle \chi_d \rangle / \mu_{2d}^{1/2}$ tends to be constant (1.6 ± 0.2) for intermediate mass ratios and low energies. The result was a series of estimates of $\langle \chi_d \rangle$ which could be shown to be closely similar to the exact Thomas–Fermi values of Winterbon. (auth)

4326 CARRIER GENERATION IN GERMANIUM IMPLANTED WITH ALUMINUM AT ROOM TEMPERATURE. Ohdomari, Iwao; Itoh, Tadatsugu (Waseda Univ., Tokyo). Jap. J. Appl. Phys.; 11: No. 11, 1709-12(Nov 1972).

Nearly intrinsic p-type germanium was implanted with aluminium ions of 10 keV at room temperature. Carrier distribution and the temperature dependences of $(N_s)_{eff}$ and μ_{eff} of aluminium-implanted layers in the substrates were investigated. Results show that two kinds of acceptors were introduced in germanium by aluminium implantation: the one associated with vacancy and the other formed by substitutional aluminum atom. The acceptor associated with vacancy had a shallow ionization level as well as that associated with substitutional aluminum atom so that the conductivity of the implanted layer had scarcely any temperature dependence between 77 and 300°K. (auth)

4327 EFFECT OF ELECTRON IRRADIATION ON EDGE EMISSION SPECTRA IN CdTe. Taguchi, Tsunemasa; Shirafuji, Junji; Inuishi, Yoshio (Osaka Univ., Suita, Japan). Jap. J. a Appl. Phys.; 11: No. 11, 1735(Nov 1972).

Annealing properties of the 4.2°K edge emission spectrum (1.30 to 1.60 eV) were investigated in as-grown and heat-treated p-type CdTe single crystals irradiated with 2-MeV electrons at 77°K. Before irradiation, the spectrum had peaks at 1.587 and 1.572 eV, 1.528 eV and its phonon replicas, and a broad band at 1.44 eV. Electron irradiation followed by room-temperature annealing reduces the 1.587- and 1.572-eV bands and enhances the 1.528-eV band and its phonon wings. The effects of firing in excess Cd vapor at 900°C and in a dissociative Cd vapor pressure on the irradiation-induced changes in the spectrum were studied. (D.L.C.)

4328 PROCEDURE FOR MODIFYING THE OPTICAL PROPERTIES OF A TRANSPARENT MEDIUM ACCORDING TO A GIVEN LAW. Sinai, P. French Patent 1,602,260. 11 Dec 1970. Filed 11 Mar 1965. (In French).

A method of modifying the refractive index of a transparent medium by irradiation is described. The method is particularly suitable for correcting spherical aberrations in lenses. In this method, a suitable attenuator is used to modify the neutron beam such as to produce a convenient variation in the refractive index. Heat treatment is then used to restore the transmission without changing the variations induced in the refractive index. Irradiation (γ rays) with an intermediate screen interposed between the object and the source enables transmission characteristics following a given law to be obtained. (France)

4329 FORMATION MECHANISM OF COLOR CENTERS IN ALKALI HALIDE CRYSTALS. Hirai, Masamitsu (Tohoku Univ., Sendai). Oyo Butsuri; 41: No. 7, 666-83(Jul 1972). (In Japanese).

Formation mechanisms of color centers in alkali metal halide crystals are reviewed from experimental results by a pulsed electron beam (30 MeV, 0.8 A, 10 ns or 0.5 MeV, 7000 A, 3 ns). Negative ion vacancies had been considered to be main products due to radiation effects in alkali metal halide crystals. According to the pulsed-electron-beam results, however, it is rather plausible to suggest that the Frenkel pair consisting of a negative-ion vacancy with an electron (F center) and an interstitial halogen atom (H center) is the primary main product due to the radiation. Excitons play an important role in the production of such a Frenkel pair. The characteristics of color centers, absorption, and emission bands due to color centers, and defects related to the color center production in all crystals investigated up to date are summarized in tables. (auth) (Japan)

4330 EFFECTS OF AN INTENSE FLUX OF FAST AND SLOW NEUTRONS ON THE MAGNETIC PROPERTIES OF STEEL. Vogel, Herbert F. (Los Alamos Scientific Lab., N. Mex.). pp 1205-11 of Proceedings of the Third International Conference on Magnet Technology. Hamburg; Deutsches Elektronen-Synchrotron (1970).

From 3rd international conference on magnet technology; Hamburg, Germany (19 May 1970). See CONF-700503.

Steel ring samples of the AISI grades C1019 and C1004 and of Armco steel were inserted in the core of the Omega West Reactor at Los Alamos Scientific Laboratory. The fast flux was 8×10^{13} $[(cm^2\ sec)^{-1}]$ and the thermal flux 4×10^{13} $[(cm^2\ sec)^{-1}]$, approximately. The temperature was 41 to 45°C as monitored at the sample surface. The samples were all excited in series, with magnetizing forces up to 15 [A/cm] at a cycling frequency of 0.5 Hz. The magnetic characteristics were obtained by plotting the hysteresis loops before, during, and after the reactor was run at power. While the reactor was run at power, a reduction of a few percent in coercive force was observed, which remained after power had been shut down. No other significant changes were observed. (auth)

4331 FORMATION OF DONOR CENTER IN SILICON BY HOT-PROTON IRRADIATION. Konaka, M.; Abe, T.; Ohmura, Y.; (and others) (Tokyo Shibaura Electric Co., Ltd., Kawasaki, Japan). J. Jap. Soc. Appl. Phys., Suppl.; 41: 220-4(1972).

From 3rd conference on solid state devices; Tokyo, Japan (1 Sep 1971). See CONF-710965.

A new kind of donor center in silicon crystal was formed by hot-proton irradiation. The donor center has a shallow level and is very stable at high temperatures such as 1100°C. Several kinds of silicon crystals were examined to investigate the origin of this donor center. The concentration of the formed donor center strongly depends on carbon content of the silicon, but not on oxygen content or dislocation densities. Shapes and peak positions of the donor center concentration profiles also depend on carbon content. There are proton beam current dependence and irradiation time dependence of the concentration of the formed donor center. The donor center concentration has a minimum value at about 15 $\mu A/cm^2$ proton beam. The donor center concentration reaches a maximum after a few minutes' irradiation by a proton beam of about 35 $\mu A/cm^2$ and then decreases by further irradiation. Applications of this phenomenon to silicon device fabrication, e.g., isolation technique for integrated circuits and improvement of collector region of microwave transistors, are included. (auth)

4332 REVERSE ANNEALING OF BORON- AND PHOSPHOROUS-IMPLANTED SILICON. Yoshihiro, Naotsugu (Hitachi, Ltd., Tokyo); Ikeda, Takahide; Tamura, Masao; Tokuyama, Takashi; Tsuchimoto, Takashi. J. Jap. Soc. Appl. Phys., Suppl.; 41: 225-30(1972).

From 3rd conference on solid state devices; Tokyo, Japan (1 Sep 1971). See CONF-710965.

Sheet-resistivity and Hall measurements were made on boron- and phosphorus-implanted (111) silicon. The energy of implant was between 50 and 150 keV. Features of the annealing curves are discussed. The reverse annealing effect is observed in boron implants at 80°K and room temperature. The effect disappears upon subsequent bombardment by neon ions. The phosphorus implants show a similar reverse annealing effect when implantation is conducted at an elevated temperature. An electron microscopic study of secondary defects in the phosphorus-implanted layer revealed their apparent similarity to those in the boron-implanted layers. (auth)

4333 INFRARED-ABSORPTION INVESTIGATION OF RADIATION DEFECTS IN ION-DOPED SILICON. Baranova, E. K. (Inst. of Atomic Energy, Moscow). Sov. Phys.-Semicond. (Engl. Transl.); 6: No. 2, 322-3(Aug 1972).

Translated from Fiz. Tekh. Poluprov.; 6: No. 2, 380-2(Feb 1972).

A study was made of the appearance and annealing of divacancies during irradiation of Si single crystals with B^+, O^+, Si^+, and N^+ ions at 18 to 80 keV. The 1.8-μ peak was present in all the irradiations, and is attributed to divacancies. The irradiation shifted the fundamental absorption edge toward longer wavelengths; when the dose is sufficient for amorphization, the 1.8-μ peak becomes indistinguishable from the absorption edge background. A spectrum taken at 77°K shows two peaks near 1.8 μ. Annealing of B-ion-implanted samples up to 400°C destroys the 1.8-μ peak and the additional edge absorption. The initial oxygen content did not exceed 10^{16} cm^{-3}; therefore, the 1.8-μ peak was not due to V–O complexes. (D.L.C.)

4334 CALCULATION OF THE NUMBER OF DEFECTS GENERATED BY BOMBARDMENT OF SILICON WITH FAST NEUTRONS. Kosmach, V. F.; Kulakov, V. M.; Ostroumov, V. I.; Petukhov, A. M. (Leningrad Polytechnic Inst.). Sov. Phys.-Semicond. (Engl. Transl.); 6: No. 2, 364-6(Aug 1972).

Translated from Fiz. Tekh. Poluprov.; 6: No. 2, 420-2(Feb 1972).

Detailed calculations are reported of the number of Frenkel defects formed in a Si crystal as a result of bombardment with neutrons of energies 0.13, 1.0, 2.05, 3.1, 6.0, and 14.1 MeV. The calculations were carried out by the Monte Carlo (random sampling) methods, and the probability density of the number of defects is plotted for each neutron energy. The dependence of the average defect concentration on neutron energy is also plotted and compared with Kramer–Ageev, Kinchin–Pease, and Linhard calculations. (D.L.C.)

4335 DIVACANCY–DONOR COMPLEXES IN OXYGEN-FREE γ-IRRADIATED GERMANIUM. Goncharov, L. A.; Emtsev, V. V.; Mashovets, T. V.; Ryvkin, S. M. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 6: No. 2, 369-70(Aug 1972).

Translated from Fiz. Tekh. Poluprov.; 6: No. 2, 424-6(Feb 1972).

Experiments were conducted to yield information on the nature of centers formed in "oxygen-free" ($O \leq 3 \times 10^{15}$ cm^{-3}) n-type Ge after the n–p conversion. Irradiation by ^{60}Co γ rays at 280°K produced vacancy–donor complexes followed by n–p conversion and the formation of defects with acceptor levels in the lower half of the forbidden band (E_v + 0.12 eV for P- and As-doped Ge and E_v + 0.14 eV for Sb-doped Ge). Saturation values for the latter centers were in good agreement with the donor concentrations, and these centers are attributed to divacancy–donor complexes. The E_v + 0.27 eV and E_c – 0.2 eV levels observed earlier are attributed to defect–oxygen complexes. (D.L.C.)

4336 RECOMBINATION RADIATION EMITTED BY ELECTRON-EXCITED CADMIUM DIPHOSPHIDE. Vavilov, V. S.; Koval, V. S.; Negrii, V. D.; (and others) (Moscow State Univ.). Sov. Phys.-Semicond. (Engl. Transl.); 6: No. 2, 241-5(Aug 1972).

Translated from Fiz. Tekh. Poluprov.; 6: No. 2, 281-6(Feb 1972).

To examine the nature of the interband transitions and the radiative recombination mechanisms in CdP_2, luminescence under electron excitation at 63 to 300°K and under photoexcitation at 13°K was studied for material grown by sublimation. A fine structure was observed in the photoluminescence spectra, caused by radiative recombination of an exciton–impurity complex in which 18 MeV optical phonons and 6 MeV acoustic phonons participate. At 63°K, four lines with energies 2.090, 2.107, 2.126, and 2.135 eV were observed in the cathodoluminescence spectrum, the position of the first three correlating with the corresponding photoluminescence peaks at 13°K if account is taken of the decrease in the energy gap with decreasing temperature. The peak at 2.135 eV is attributed to the radiative recombination of free excitons. The recombination mechanisms proposed were used to determine the dissociation energy of the exciton complex (equal to 9 MeV), the binding energy of a free exciton (16 ± 3 MeV), and the energy gap arising from the direct interband transitions (2.151 ± 0.004 eV at 63°K). (auth)

4337 ELECTRON MICROSCOPE INVESTIGATION OF THE FINE STRUCTURE OF γ-IRRADIATED CRYSTALS OF TRIGLYCINE SULFATE. Distler, G. I.; Yurin, V. A.; Gerasimov, Yu. M.; Belugina, N. V.; Meleshina, V. A. (Inst. of Crystallography, Moscow). Izv. Akad. SSSR, Ser. Fiz.; 36: No. 6, 1336-40 (Jun 1972). (In Russian).

Samples of triglycine sulfate were excised from well-developed pyramids and irradiated at room temperature for doses of from 0.5 to 15 MR of gamma rays from a ^{60}Co source. Examination with an electron microscope provided visualization of the elements of actual and domain structures; the most radiation-sensitive were the elements of the reticular structure, i.e., point defects and their accumulation and linear polarization of bridges between them. (K.S.W.)

4338 INVESTIGATION OF THE CAPACITIVE PROPERTIES OF SILICON n^+–p DIODES IRRADIATED WITH FAST ELECTRONS. Berman, L. S.; Kreinin, L. B.; Nasredinov, F. S. (Inst. of Semiconductors, Leningrad). Sov. Phys.-Semicond. (Engl. Transl.); 6: No. 2, 252-6(Aug 1972).

Translated from Fiz. Tekh. Poluprov.; 6: No. 2, 294-9(Feb 1972).

Investigations were made of the electrical properties of radiation defects formed in the bases of silicon n^+–p diodes irradiated with fast electrons. These properties were determined from the change of the capacitance with time during charge exchange in the dark between the deep impurity levels corresponding to the radiation defects and also from the change of the steady-state value of the capacitance after irradiation. The irradiation gave rise to levels at $E_v + 0.17$, $E_v + 0.21$, $E_v + 0.34$, and $E_c - 0.24$ eV. The concentration of the defects corresponding to these levels was determined. For the first three levels the order of magnitude was determined for the cross section for the capture of holes; for the fourth, for electrons. The high sensitivity of the capacitive method made it possible to determine the rate of introduction of defects at low irradiation doses. (auth)

4339 GETTERING RATES OF VARIOUS FAST-DIFFUSING METAL IMPURITIES AT ION-DAMAGED LAYERS ON SILICON. Buck, T. M. (Bell Telephone Labs., Murray Hill, N. J.); Pickar, K. A.; Poate, J. M.; Hsieh, C.-M. Appl. Phys. Lett.; 21: No. 10, 485-7(15 Nov 1972).

High-temperature gettering of Fe, Co, Ni, Cu, and Au by ion-damaged surface layers on silicon wafers was studied by Rutherford backscattering of $^4He^+$ ions incident at 1.75 or 2 MeV. Analysis showed impurity levels in the damaged layers ranging from 10^{13} to $10^{17}/cm^2$. The metals fall into two groups: those which are gettered slowly — Fe, Co, and Au — and those gettered rapidly — Cu and Ni. This trend is predicted by a simple diffusion model using published interstitial solubilities and diffusivities. (auth)

Physical Properties

Refer also to abstracts 2869, 2889, 2913, 2967, 2973, 3969, 4075, and 4755.

4340 (BNWL-1671) ELECTRICAL CONDUCTIVITY OF THORIUM DIOXIDE. Bates, J. L.; Schemmel, R. R. (Battelle Pacific Northwest Labs., Richland, Wash.). Jun 1972. Contract AT(45-1)-1830. 56p. Dep. NTIS.

The electrical conductivity of ThO_2 was measured from near room temperature to 2500°C. Measurements were also made to 800°C in a high-intensity gamma radiation field. A review of the preliminary data is presented. Experimental difficulties relating to high-temperature measurements and measurements in gamma field are discussed in detail. Reported electrical conductivity data for ThO_2 is reviewed, considering such variables as temperature, oxygen pressure, impurities, and polarization. It is concluded that the wide variations in reported electrical conductivity data result principally from variations in oxygen pressures, sample compositions, and experimental techniques. At high temperatures, experimental measurements are complicated by the presence of large thermionic emission currents, gas conduction, and polarization. The reported increases in conductivity induced by gamma radiation are related to the ionization of the gas surrounding the sample instead of induced solid-state conduction. ThO_2 is a mixed ionic–electronic conductor, depending upon the oxygen pressure and dopant composition. It is a p-type conductor at low temperatures and an apparent n-type conductor above 1400°C. (49 references, 11 figures, 4 tables) (auth)

4341 (COO-1441-16) ELECTRICAL CONDUCTIVITY OF CaO-DOPED NONSTOICHIOMETRIC CERIUM DIOXIDE FROM 700^0 TO 1500^0C. Blumenthal, R. N.; Brugner, F. S.; Garnier, J. E. (Marquette Univ., Milwaukee, Wis. Coll. of Engineering). 1972. 38p. Dep. NTIS.

The electrical conductivity of sintered specimens of CaO-doped CeO_2 (0.1 to 16.0 mole %) was measured over the temperature range 700 to 1500°C and from 1 to 10^{-22} atm of oxygen. All specimens of CaO-doped CeO_2 exhibited mixed conduction. Predominantly ionic conductivity was observed at low temperatures and high oxygen partial pressures. Conversely, high temperatures and lower oxygen partial pressures were dominated by electronic conductivity. CaO-doped CeO_2 exhibited both electronic and ionic conductivity. Two limiting case regions were observed. At low temperatures and high oxygen pressures, the conductivity is predominantly ionic. In this region the conductivity is independent of P_{O_2} and between approximately 1 and 8 mole % CeO is proportioned to mole % CaO. The following equation for ionic conductivity $\sigma_i \simeq 6.0 \pm 0.5[\text{mole \% CaO}] \exp^{-0.62/kT}$ was obtained by fitting the conductivity data in this region to an expression derived on the basis of an oxygen vacancy model. An approximate expression for the diffusion coefficient for oxygen vacancies, $D_{V_0^{\cdot\cdot}} = 3.7 \times 10^{-3}\, e^{-0.62/kT}$, was calculated from the above expression and the Nernst–Einstein relation. At high temperatures and low oxygen partial pressures and for lower CaO contents, the conductivity is predominantly electronic. In this region, σ decreases with increasing CaO addition and the magnitude and P_{O_2} dependence of σ is similar to "pure" CeO_2. A thermodynamic argument is presented which favors oxygen vacancies as the nonstoichiometric defect in both "pure" and CaO-doped CeO_2. (auth)

4342 (COO-1441-17) TEMPERATURE DEPENDENCE OF THE ELECTRICAL CONDUCTIVITY OF NONSTOICHIOMETRIC CeO_{2-x}. Blumenthal, R. N.; Hofmaier, R. L. (Marquette Univ., Milwaukee, Wis. Coll. of Engineering). 1972. 32p. Dep. NTIS.

The electrical conductivity of sintered specimens of nonstoichiometric CeO_{2-x} was measured as a function of temperature from 1000 to 300°C and composition from $0.00424 \leq x \leq 0.178$. Results were described in terms of a high-temperature and low-temperature region. In both regions, the conductivity for fixed values of x exhibits an exponential dependence on temperature $\sigma = \sigma_0 e^{-Q/kT}$. In the high-temperature region, the activation energy increased with increasing values of x (i.e., 0.22 eV at x = 0.00424 to 0.37 eV at x = 0.178). The activation energy, 0.61 ± 0.03 eV, in the low-temperature region was independent of x. The temperature of the intersection between the high- and low-temperature regions for each composition was compared with the composition–temperature dependence of the miscibility gap reported by Brauer and Gingerich. The compositional and temperature dependence of the conductivity in the high-temperature region which corresponds to a single-phase region may be represented by the following expression $\sigma \propto x e^{-Q/kT}$, where Q is a function of x. This expression was rationalized in terms of the following simple relations for the electron carrier concentration $[Ce'_{Ce}] \propto x$ and the electron mobility $\mu = \mu_0 e^{-Q/kT}$, where μ_0 is independent of x, Q is independent of x from $-3.0 < \log x < -1.8$, and Q is a function of x from $-1.8 < \log x < -0.7$. (auth)

4343 (HEDL-TME-72-73) RESISTIVITY MEASUREMENTS OF INSULATORS AT HIGH TEMPERATURES USING THE FOUR-PROBE TECHNIQUE. Schemmel, R. R.; Philipp, L. D.; Gordon, R. L.; Bates, J. L. (Hanford Engineering Development Lab., Richland, Wash.). Mar 1972. Contract AT(45-1)-2170. 42p. Dep. NTIS.

Experimental measurements demonstrated that insulation polarization and thermionic emission of test apparatus significantly reduce accuracy of dc resistivity measurements made on metal oxide electrical insulators at 900 to 2100°C. Experimental methods that will minimize these effects are described. (auth)

4344 (LBL-666, pp 177-231) CHEMICAL AND ATOMIC PHYSICS. May 1972.

In Nuclear chemistry annual report, 1971.

AMERICIUM IONS — radiation effects on calcium fluoride doped with, absorption spectral and thermoluminescence study of, (pp 191-2)
— crystal field splittings of trivalent, in strontium fluoride, (pp 193-4)
CALCIUM FLUORIDES — radiation effects on trivalent actinide ions in, absorption spectral and thermoluminescence study of γ, (pp 191-2)
CARBON MONOXIDES — electron reactions at 8.3 eV, spectrum of photon emission in, (pp 189-90)
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—Moessbauer spectrum in rhenium metal, electric quadrupole splitting in, (pp 199-201)
THORIUM OXIDES ThO_2—crystal field splittings of trivalent curium ions in, (pp 193-4)
URANIUM—complexes with 1,3,5,7-tetramethylcyclooctatetraene, proton NMR of, (pp 194-6)
URANIUM IONS—radiation effects on calcium fluoride doped with, absorption spectral and thermoluminescence study of, (pp 191-2) (D.L.C.)

4345 (NP-19481) TABLES OF MAGNETIC STRUCTURES DETERMINED BY NEUTRON DIFFRACTION. SUPPLEMENT II. Oles, A.; Kajzar, F.; Kucab, M. (comps. and eds.) (Institute of Nuclear Techniques, Krakow (Poland)). Jul 1972. 73p. (INT-24). Dep. NTIS (U. S. Sales Only).

Tables of the magnetic structures determined by neutron diffraction were elaborated on the basis of the original papers. The tables contain the chemical symbol of the substance, its space group, crystallographic data, cation distribution, temperatures of magnetic transitions, a brief description of magnetic structure including some figures, magnetic moments and their directions, effective magnetic moments, and references on magnetic additional properties. Magnetic space groups for stoichiometric compounds are given. This supplement contains compounds and alloys omitted in previous parts. Approximately 270 references are arranged by year. (auth)

4346 THERMAL AND ELECTRICAL CONDUCTIVITIES OF TANTALUM AT HIGH TEMPERATURES. Vertogradskii, V. A. High Temp. (USSR) (Engl. Transl.); 10: No. 1, 64-7(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 77-81(1972).

The thermal conductivity of tantalum was measured at 1400 to 3000°K with an error of 2.5 to 4.5%, and the electrical resistivity was measured at 1200 to 3000°K with an error of less than 1%. The second temperature derivative of the electrical resistivity was found to depart from linearity in the region of 2100°K. The most probable values of the thermal conductivity and electrical resistivity were calculated from groups of data by various authors that are in good agreement. (auth)

4347 POSITRON ANNIHILATION AND THE BAND STRUCTURE IN MOLYBDENUM. Kim, S. M.; Buyers, W. J. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 50: No. 15, 1777-81(1 Aug 1972).

Measurements have been made of the two-photon angular correlation from positrons annihilating in single-crystal molybdenum at room temperature. By means of a combination of conventional slits and Soller slits the number of annihilations for which the momentum lies along a line in the momentum distribution is obtained, and results are presented for the [ζ,ζ,0], [0,0,ζ], and [ζ,ζ,0.71] directions. Theoretical calculations of the angular correlation have been made based on the interpolation or pseudopotential scheme with s–d interaction included. The parameters of the interpolation scheme have been chosen so that an accurate representation is obtained of the APW band structure of Mattheiss. The positron wave function has been obtained in terms of 141 plane waves. The width of the calculated two-photon angular correlation is found to be much broader than the experimental width unless the relative s and d enhancement is considered. (auth) (Canada)

4348 PERFORMANCE EVALUATION OF THIN FILM MULTILAYER SYSTEMS USING ELECTRONIC DIGITAL COMPUTER. Vijayalaxmi, M. V.; Ramakrishna Rao, M. (Indian Inst. of Science, Bangalore). Indian J. Pure Appl. Phys.; 10: No. 1, 43-7(Jan 1972).

A general program to evaluate the performance of a dielectric multilayer system, in terms of reflectance and transmittance, was developed. The program is very efficient and permits control over all the parameters on which reflectance and transmittance depend. The performance of some typical systems, e.g., ZrO_2/MgF_2, ZnSe/MgF_2, ZnS/$ThOF_2$, ZrO_2/Na_2AlF_6, and CeO_2/MgF_2, was evaluated using this program. The effect of constructional parameters, such as thicknesses and refractive indices of the component films, on the performance of the system was theoretically investigated and results presented in the form of a series of graphs. (auth)

4349 GALVANOMAGNETIC AND THERMOELECTRIC PROPERTIES OF U_3P_4 AND U_3As_4. Henkie, Z. (Inst. for Low Temperature and Structure Research, Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Chim.; 20: No. 6, 531-8(1972).

The Hall effect (between 77 and 450°K) and the thermoelectric power (between 90 and 800°K) were examined for U_3P_4 and U_3As_4. The anomalous Hall constants (R_s) equal to 2.76×10^{-8} (V · cm/A · gauss) and 6.9×10^{-8} (V · cm/A · gauss) for U_3P_4 and U_3As_4 respectively are higher by 4 orders than the ordinary Hall constant (about 5×10^{-12} (V · cm/A · gauss)). Since R_s varies with temperature like the magnetic part of the resistivity ρ_m ($R_s \sim \rho_m$), it is concluded that the scattering of conductivity electrons is affected predominantly by spin disorder of the localized magnetic electrons. The value of the Fermi energy ($E_F \approx 1$ eV) and the effective mass ($m^*/m_0 \approx 3.3$) were estimated on the basis of the temperature dependence of the thermoelectric power. (auth)

4350 MAGNETIC PROPERTIES OF RARE EARTH TETRABORIDES. Buschow, K. H. J.; Creyghton, J. H. N. (Philips Research Labs., Eindhoven, Netherlands). J. Chem. Phys.; 57: No. 9, 3910-14(1 Nov 1972).

The magnetic properties and the lattice constants of the rare earth tetraborides RB_4 were determined. The compound PrB_4 is ferromagnetic. The compounds in which R represents Nd, Sm, Gd, Tb, Dy, and Ho are antiferromagnetic while ErB_4 and YbB_4 show metamagnetic behavior. The element Ce and to some extent also the element Yb show an abnormal valency in the tetraborides. The magnetic properties of the RB_4 compounds are discussed in terms of the RKKY formalism. It is shown that the ferromagnetic behavior of PrB_4 is probably the result of a strong participating of the orbital angular momentum to the indirect exchange coupling between the localized moments. (auth)

4351 INFLUENCE OF THE CRYSTALLINE FIELD ON THE MAGNETIC RESISTIVITY OF PRASEODYMIUM. Krithivas, G. (Brandeis Univ., Waltham, Mass.); Meaden, G. T.; Sze, N. H. J. Phys. Soc. Jap.; 33: No. 6, 1584-90(Dec 1972).

Resistivity measurements on high-purity polycrystalline praseodymium are reported for temperatures from 4°K to the ice-point. Many of the features of the temperature dependence can be accounted for satisfactorily for the first time. The discovery of a conspicuous anomaly at 22.2°K is correlated with an antiferromagnetic–paramagnetic transition in the dhcp crystal structure. The magnetic resistivity is separated from the phonon resistivity and found to have an unusual variation with temperature. This is understandable in terms of the effect on the magnetic resistivity of the crystalline field in splitting the ground state of the magnetic praseodymium ions. (auth)

4352 NEUTRON INELASTIC SCATTERING EXPERIMENT ON TiH_2 AND YH_2. Kimura, Motoharu; Watanabe, Noboru; Oyamada, Masayuki (Tohoku Univ., Sendai). Kakuriken Kenkyu Hokoku; 3: No. 2, 65-72(Dec 1970). (In Japanese).

Measurement of neutron inelastic scattering was carried out for TiH_2 and YH_2 to study optical levels of metallic hydrides of CaF_2 type. Samples used for the measurement were TiH_2 and YH_2 powders; lattice constants measured by x-ray diffraction method and gas analysis confirmed their composition. Samples were placed at an angle of 45° to the incident beam. Measurement methods were chopper–monochromator method and BeO filter method. Slit width of the chopper was 50 ± 2 μsec, and measured scattering angle was 33, 54, 80, and 101°. Differential cross sections measured by the chopper method are compared with theoretical values. Dependence of elastic scattering cross section on momentum transfer and BeO filter spectra are also shown. Optical levels and level width were obtained from data, and the difference between the levels of TiH_2 and YH_2 was recognized. It was confirmed that the optical levels were lowered with increasing mass number of the metals. Multiphonon processes were observed up to fourth levels in the TiH_2 and YH_2 by the use of BeO filter method. (Japan)

4353 MAGNETIC PROPERTIES OF RARE-EARTH ALLOYS OF DYSPROSIUM, HOLMIUM, AND ERBIUM AT 4.2°K. Belov, K. P.; Elyutin, O. P.; Kataev, G. I.; (and others) (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz.; 36: No. 6, 1247-51(Jun 1972). (In Russian).

Alloys of Dy–Ho–Er were investigated for saturation magnetization in fields up to 50 kOe at 4.2°K, and values were obtained for coercive force, residual magnetism, and hysteresis loops for about 50 compositions. The critical magnetizing field at which magnetization of the alloy samples increases sharply was observed. Temperature dependence of magnetization of the composition $Er_{0.6}Ho_{0.2}Dy_{0.2}$ was studied in a superconducting solenoid with a vibration magnetometer. The ferromagnetic spiral–antiferromagnetic spiral transition had a diffuse character over the temperature range 13 to 56.3°K. In the case of this same composition, H_k regularly increased from 19 kOe at 4.2°K to 28 kOe at 56°K for both the ferromagnetic and antiferromagnetic regions. (K.S.W.)

4354 MAGNETIC STRUCTURES OF SAMARIUM. Koehler, W. C.; Moon, R. M. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 29: No. 21, 1468-72(20 Nov 1972).

The magnetic structures of metallic samarium were determined from neutron-diffraction data on a single crystal of ^{154}Sm. Anomalies in a number of physical properties of this metal at 106 and 13.8°K are associated with ordering of the moments on the hexagonal and cubic sites, respectively. The unusual form factor expected for a $4f^5$ configuration was observed. Striking evidence for important conduction-electron polarization effects was found. (auth)

4355 TRANSITION METAL HYDRIDES. Muetterties, E. L. (ed.). Hydrogen Series, Volume 1. New York; Marcel Dekker, Inc. (1971). 357p. $14.50.

This book has its emphasis on molecular transition metal hydride (TMH) chemistry. The six chapters, with an extensive bibliography to each, cover the physical properties of H, D, and T; transition metal–H interaction; molecular structures of TMH complexes; stereochemistry and nonrigidity in TMH; systematics of TMH chemistry; and role of TMH in homogeneous catalysis. Author and subject indexes are included at the end. Separate abstracts were prepared for the first two chapters. (D.L.C.)

For abstracts of individual chapters see: 2654 and 4356.

4356 TRANSITION METAL–HYDROGEN INTERACTION. Muetterties, E. L. (E. I. du Pont de Nemours and Co., Wilmington, Del.). pp 11-31 of Transition Metal Hydrides. /Muetterties, E. L. (ed.). New York; Marcel Dekker, Inc. (1971).

After a brief consideration of gaseous diatomic hydrides, solid binary hydrides are discussed from the electronegativity standpoint. The hydrides of Ti, Zr, Hf, V, Nb, Ta, Cr, and Pd are discussed, and the large family of ternary metal hydrides is considered briefly. Bonding in the metallic hydrides is discussed. Finally, chemisorption is discussed. (84 references) (D.L.C.)

4357 CYCLOTRON RESONANCES IN GRAPHITE BY USING CIRCULARLY POLARIZED RADIATION. Suematsu, H.; Tanuma, S.-I. (Tokyo Univ.). J. Phys. Soc. Jap.; 33: No. 6, 1619-28(Dec 1972).

Cyclotron resonances in single-crystal graphite (SCG) and pyrolytic graphite (PG) were investigated at about 23 and 69 GHz. A sequence of harmonic resonances is observed for either sense of circular polarization, while the fundamental resonance is found for the polarization sensitive to electron. These resonances are analysed to originate from the electron Fermi surface centered at K-point in the Brillouin zone, of which large trigonal warping is deduced. The observed cyclotron masses are $m_e/m_0 = 0.058 \pm 0.001$ (at 69.08 GHz) for SCG and 0.059 ± 0.001 (at 68.01 GHz) for PG. Two kinds of additive structures in SCG, one being observed at 23 GHz and the other at 69 GHz, are discussed after the theoretical study by Uda, Ushio, and Uemura of a nonlocal effect of the hole resonance and an electron–hole interaction, respectively. Each resonance field has the angular dependence of $(\cos\theta)^{-1}$, where θ is the angle between the applied magnetic field and the hexagonal axis. (auth)

4358 THEORY OF CYCLOTRON RESONANCE OF GRAPHITE. I. DETERMINATION OF THE DEGREE OF BAND WARPING. Ushio, H.; Uda, T.; Uemura, Y. (Tokyo Univ.). J. Phys. Soc. Jap.; 33: No. 6, 1551-60(Dec 1972).

Experimental results presented by Suematsu and Tanuma (ibid., 33: No. 6, 1619-28) are analyzed theoretically. The value of the warping parameter γ_3 is determined as 0.21 eV by fitting the calculated reflectivity curve to the observed one. The calculations are made on the local, single-particle approximation. The influence of the choices of other band parameters on the value of γ_3 is also examined in detail. (auth)

4359 ELECTRICAL CONDUCTIVITY OF INTERMETALLIC COMPOUNDS OF THE PRASEODYMIUM–THALLIUM SYSTEM. Spacu, P.; Cismaru, G. D. (Centre of Physical Chemistry, Bucharest). Rev. Roum. Chim.; 17: No. 10, 1723-8(Oct 1972).

The electric conductivity of intermetallic compounds of the Pr–Tl system was studied. The conductivity variation within the system confirmed the formation of Pr_5Tl_3, PrTl, and $PrTl_3$ compounds and negated the existence of the Pr_2Tl compound. An exponential increase of conductivity was observed on increasing the atomic fraction of Tl. Values of $N_A^{\frac{1}{3}}l$ product for each compound of Drude's corrected equation were determined. (auth)

Moessbauer Effects and NMR

Refer also to abstract 4324.

4360 (LYCEN–7223) MICROSTRUCTURE AROUND THE Tm ION OBSERVED BY PERTURBED ANGULAR CORRELATION MEASUREMENTS. Haroutunian, Roger (Lyon Univ. (France). Institut de Physique Nucleaire). Apr 1972. 50p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The origin and behavior of hyperfine magnetic fields in condensed matter are reviewed. Angular correlation measurements carried out on the ^{169}Tm nucleus in dilute solutions of ytterbium in silver and in iron–ytterbium garnet are described. Results reflect the behavior of the microstructure of the solid around the radioactive nucleus, the latter being used as a probe. (42 references) (France)

4361 (STI/PUB-304) MOESSBAUER SPECTROSCOPY AND ITS APPLICATIONS. Panel Proceedings Series. Proceedings of a Panel Held in Vienna, 24–28 May 1971. (International Atomic Energy Agency, Vienna (Austria)). Jun 1972. 427p. (CONF-710561). IAEA $13.00.

This panel reviews the present status of the Moessbauer technique and its applications in chemistry, solid-state physics, and nuclear chemistry, particularly in the developing countries. Eighteen papers and a summary discussion are included. Separate abstracts were prepared for five of the papers. (D.L.C.)

For abstracts of individual papers see: 4324 and 4364–4367.

4362 EXACT QUANTUM-MECHANICAL THEORY OF SPIN–SPIN INTERACTION AND NUCLEAR MAGNETIC RESONANCE. Conte, E. (Univ., Bari, Italy). Lett. Nuovo Cim.; 5: No. 5, 425-30(30 Sep 1972).

A new treatment is presented of the spin–spin interaction. The stationary eigenfunctions of a spin nuclear system and NMR transition energies are obtained exactly. The treatment can be extended from the two-nucleus spin system to a many-spin system. (D.L.C.)

4363 ANOMALOUS TEMPERATURE DEPENDENCE OF RECOILLESS EMISSION: ^{161}Dy IN MOLYBDENUM. Rork, E. W.; Jastram, P. S. (Ohio State Univ., Columbus). Phys. Rev. Lett.; 29: No. 19, 1297-9(6 Nov 1972).

The Moessbauer recoilless fraction is found to show anomalous temperature dependence for a ^{161}Dy source in a molybdenum metal host, decreasing by almost a factor of 5 as the temperature decreases from 300 to 25°K, then increasing again at 4.2°K. (auth)

4364 RECENT IMPROVEMENTS IN INSTRUMENTATION AND METHODS OF MOESSBAUER SPECTROSCOPY. Kalvius, G. M. (Argonne National Lab., Ill.); Kankeleit, E. pp 9-88 of Moessbauer Spectroscopy and Its Applications. Vienna; International Atomic Energy Agency (1972).

From Panel on Moessbauer spectroscopy and its applications; Vienna, Austria (24 May 1971). See STI/PUB-304; CONF-710561.

Recent advances in velocity spectrometers for Moessbauer spectroscopy and other related instrumentation are reviewed. In addition, a brief discussion on modern methodology and its application to certain problems of current interest is given. A standard electromechanical spectrometer using modern circuit elements is described in detail. The expansion of such a system for recording more than one spectrum simultaneously with minimum dead-time losses together with the problems connected with the spectroscopy using very high count rates is then discussed. A review concerning the use of minicomputers for Moessbauer spectroscopy follows. Special drive systems, like piezoelectric transducers for very low velocities, as well as systems for very high velocities and those for highly radioactive absorbers, are described. The discussion on methodology includes a survey of computer fitting routines, the production and use of ultralow temperatures, and the construction of polarized sources. The calibration procedures of Moessbauer spectrometers is discussed. A short review on more recent cryostat and oven design is also included. (44 figures, 119 references) (auth)

4365 MOESSBAUER SPECTROSCOPY IN THE ACTINIDES. Kalvius, G. M. (Argonne National Lab., Ill.). pp 169-96 of Moessbauer Spectroscopy and Its Applications. Vienna; International Atomic Energy Agency (1972).

From Panel on Moessbauer spectroscopy and its applications; Vienna, Austria (24 May 1971). See STI/PUB-304; CONF-710561.

The application of Moessbauer spectroscopy in the investigation of the nuclear and solid-state properties of the lighter actinides has made rapid progress in recent years. A large amount of new data, mainly concerned with the electronic structure of the 5f-transition series, has become available and is reviewed. First, a short introduction to the properties of the different Moessbauer resonances available in the actinides is given. The origin of the hyperfine parameters in the actinides and the influence of relativistic effects is discussed briefly. Next the results of isomer shifts on various compounds of ^{237}Np are compared with theo-

retical charge density calculations using the Dirac–Fock method and also with optical isotope shift data. The majority of investigations published so far deal with the magnetic properties of actinides. A survey of the present results is given, which show that magnetism in the actinides is far more complex than in the analogous rare earths. Finally a discussion is given of the electric quadrupole interaction, in particular the derivation of the inner Sternheimer shielding factor. (14 figures, 56 references) (auth)

4366 MOESSBAUER STUDIES OF CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS. Adloff, J. P.; Friedt, J. M. (CNRS, Strasbourg). pp 301-28 of Moessbauer Spectroscopy and Its Applications. Vienna; International Atomic Energy Agency (1972).

From Panel on Moessbauer spectroscopy and its applications; Vienna, Austria (24 May 1971). See STI/PUB-304; CONF-710561.

Moessbauer levels can be populated in a variety of ways: radioactive decay, neutron or charged-particle induced nuclear reactions, Coulomb excitation. The hyperfine interaction parameters obtained from the Moessbauer emission spectra describe the chemical state of the atoms in the excited nuclear state. In the case of a radioactive source, one deduces from this information the physical and chemical consequences (or "after-effects") of the nuclear decay: oxidation, reduction, molecular disruptions, production of vacancies. With a few exceptions, the available experimental data concern the electron-capture decay of ^{57}Co to ^{57}Fe in a variety of simple and complex cobalt compounds, and in ^{57}Co-doped materials. Nuclides formed in nuclear reactions acquire a high kinetic energy (hot atoms) and Moessbauer spectroscopy helps to clarify the peculiarities of recoil phenomena (slowing down of the hot atoms, recoil damage). All these phenomena have been extensively studied by radiochemical techniques. Moessbauer spectroscopy offers the unique advantage of a selective in situ diagnosis avoiding all perturbations brought about by the chemical analysis, and on a time scale typically of the order of 10^{-9} to 10^{-7} s. Direct feeding of the Moessbauer level (i.e. in the absence of an intermediate long-lived isomeric state) through a nuclear reaction or the excitation of the ground state requires an on-line experiment in a neutron or particle beam. Recoiling Moessbauer nuclides can be implanted in any material to get details on the final positions and on the surroundings of the excited nuclei. Moessbauer levels that can be populated by several different nuclear processes are particularly interesting. In some cases the radiosynthesis of new chemical species could be demonstrated. (69 references) (auth)

4367 ADVANTAGES AND LIMITATIONS OF MOESSBAUER SPECTROSCOPY IN COMPARISON TO OTHER METHODS. Huefner, S.; Matthias, E. (Freie Univ., Berlin). pp 349-80 of Moessbauer Spectroscopy and Its Applications. Vienna; International Atomic Energy Agency (1972).

From Panel on Moessbauer spectroscopy and its applications; Vienna, Austria (24 May 1971). See STI/PUB-304; CONF-710561.

The advantages and disadvantages of Moessbauer spectroscopy, as a method of measuring hyperfine interactions in solids, are reviewed. It is compared with other methods used in the study of hyperfine interactions in solids, NMR, ENDOR, ESR, perturbed angular correlations, nuclear orientation, and neutron scattering. The principal problems and limitations of the present detection technique (Doppler shift) are discussed, and the possibility of using in special cases double resonance techniques (Moessbauer–NMR) is investigated. The amplitude and frequency modulation of γ rays are mentioned. A few examples are discussed where Moessbauer spectroscopy and other methods have been used simultaneously: (a) for the investigation of iron doped with impurities to study the conduction electron polarization where Moessbauer spectroscopy, NMR, and the neutron diffraction technique have been used extensively; (b) the study of the Kondo effect in Fe : Cu in addition to extensive NMR measurements; (c) the study of static and dynamic critical phenomena where NMR and the neutron diffraction technique are competing. Finally, the information obtained from isomer shift measurements is discussed because this quantity is uniquely measured by the Moessbauer effect. (12 figures, 43 references) (auth)

4368 MOESSBAUER SPECTROSCOPY: RECENT DEVELOPMENTS. Cohen, R. L. (Bell Labs., Murray Hill, N. J.). Science; 178: No. 4063, 828-35(24 Nov 1972).

In this review, two basic points are emphasized. First, Moessbauer spectroscopy has been widely used as a tool for basic research in solid-state physics, chemical structure, and magnetism. Second, the technique has been applied to many analytical and materials science problems where the nature of the sample prevents the use of more traditional approaches. Moessbauer spectroscopy research on frozen solutions, colloids, interface chemistry, and crystallographic transformations can be expected to increase rapidly in the next few years. (10 figures, 27 references) (auth)

Theory

4369 5F ELECTRONS IN ACTINIDE METALS AND METALLIC-TYPE COMPOUNDS. Fournier, J. M. (CEN, Grenoble, France). Solid State Commun.; 11: No. 8, 925-6 (15 Oct 1972). (In French).

A qualitative covalent model is presented for the nature of 5f bonding in uranium, neptunium, and plutonium. A dual character is suggested—localized, delocalized—for the 5f electrons. It is proposed to review all metallic compounds of these metals in an hybridized band model, in particular for the magnetic properties. (auth)

4370 BONDING IN GROUP IIIb HYDRIDES: AN EMPIRICAL APPROACH. Bos, W. G. (Univ. of Louisville, Ky.). Accounts Chem. Res.; 5: No. 10, 342-7(Oct 1972).

A review is presented of the arguments made for the protonic, atomic, and hydridic models of the dihydrides of SC, Y, and the lanthanides. Experimental results which strongly favor the hydridic model are discussed and used to derive schematic band structures. These empirical band diagrams agree with theoretical calculations. (39 references) (D.L.C.)

PHYSICS (THEORETICAL)

Refer also to abstracts 3684, 3857, 3874, 3875, 3885, 3915, and 3927.

4371 (CEA-CONF-2038) PRESENTATION OF EXPERIMENTAL DATA BY A FUNCTION. Bystricky, J.; de Lesquen, A.; Lehar, F. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1972. 28p. (CONF-720423-6; DPhPE-72-6). Dep. NTIS (U. S. Sales Only).

From first European conference on computational physics; Geneva, Switzerland (10 Apr 1972).

Usually the results of a measurement are presented in the form of a series of experimental points. Another method is studied which allows one to present the results directly by way of a curve with its corridor of errors. This method eliminates the arbitrariness in the choice of the number of points and conserves the accuracy of each event. Some examples are given and suggestions are made for using such a function in a statistical analysis together with other measured data. (auth)

4372 WHY HIDDEN VARIABLES CANNOT BE INTRODUCED INTO QUANTUM MECHANICS. Akhiezer, A. I.; Polovin, R. V. (Physical-Technical Inst., Kharkov). Usp. Fiz. Nauk; 107: No. 3, 463-87(Jul 1972). (In Russian).

The statistical character in the behavior of micro-objects is considered in the light of measurement of physical quantities. The mathematical bases of quantum mechanics and the process of measurement with the concomitant interaction between the quantum object and the apparatus are discussed. The concept of "hidden parameters" propounded by von Neuman requires a fundamental break with quantum mechanics, and various models (hydrodynamic, Wiener–Siegel) are compared. Von Neuman's theory regarding the impossibility of introducing hidden variables into quantum theory without a cardinal change in its principles is mathematically examined with and without considering the additivity of mutually exclusive observations. (35 references) (K.S.W.)

4373 INTERPRETATION OF THE INTERACTION OF THE FIELD OF VACUUM FOR THE CLASSICAL APPROACH TO QUANTUM MECHANICS. Kaliski, S. (Inst. of Fundamental Technical Problems, Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech.; 20: No. 6, 189-94(1972).

A physical interpretation of the tensor of interaction of the field of vacuum and the particles based on the "classical" approach to quantum mechanics is presented. It is shown that for linearized equations the tensor of interaction of the field of vacuum characterized previously as an "imaginary volume viscosity" may be expressed on the ground of real variables as the divergence of gradient of dilatation of displacement with the interaction constant $D = (\hbar^2/4m)$. In the case of one space variable the tensor is proportional to the third derivative of displacement u with respect to x (unlike the case of mechanics of elastic medium where the tensor under consideration is proportional to the first derivative). (auth)

4374 MAXIMAL KINEMATICAL INVARIANCE GROUP OF THE FREE SCHROEDINGER EQUATION. Niederer, U. (Univ., Zurich). Helv. Phys. Acta; 45: No. 5, 802-10(1972).

The largest group of space-time transformations which leave invariant the free Schrödinger equation is found to be a 12-parameter Lie group containing the Galilei group, the dilations, and a group of projective transformations. The group is discussed, and it is shown that the Schrödinger functions carry a unitary irreducible projective representation. (auth)

4375 PURE STATES, MIXTURES, AND REDUCTION OF THE WAVE PACKET. e Silva, J. Andrade (Equipe de Recherches sur les Fondements de la Physique Quantique, Paris). Found. Phys.; 2: No. 4, 245-56(Oct 1972).

The usual distinction in quantum mechanics between pure states and mixtures is shown not be independent of the interpretation adopted. Thus, in a causal theory, certain states should be regarded as sharing the nature of both pure states and mixtures and, as a result, important questions in the theory of measurement must be considered in a different light. (auth)

4376 SURVEY OF GENERAL QUANTUM PHYSICS. Piron, C. (Univ. of Denver). Found. Phys.; 2: No. 4, 287-314(Oct 1972).

The abstract description of a physical system is developed, along lines originally suggested by Birkhoff and von Newmann, in terms of the complete lattice of propositions associated with that system, and the distinction between classical and quantum systems is made precise. With the help of the notion of state, a propositional system is defined: it is remarked that every irreducible propositional system (of more than three dimensions) is isomorphic to the lattice of all closed subspaces of a Hilbert space constructed on some division ring with involution. The propositional system consisting of a family of separable complex Hilbert spaces is treated as a particular case which is sufficiently general to include both classical and quantum mechanics. The theory of the Galilean particle without spin is given as an illustration. Finally, the basis for the statistical interpretation of wave mechanics is developed with the help of Gleason's theorem. A proof of essentially the first part of Gleason's theorem is given which is a little different (perhaps more geometric) from that originally given by Gleason. (auth)

4377 NOTE ON ROTATION MATRICES. Grosswendt, B.; Witschel, W. (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Naturforsch.; 27a: No. 8-9, 1369(1972).

A simplification of the Schwinger solution of the rotation matrices is given avoiding the unnecessarily complicated generating function trick. (J.F.P.)

4378 KINETIC EQUATION FOR ONE-PARTICLE DISTRIBUTION FUNCTION. II. Istomin, V. V.; Dovgopol, S. P. (Ural Polytechnic Inst., Sverdlovsk, USSR). Ukr. Fiz. Zh. (Russ. Ed.); 17: No. 8, 1312-18(Aug 1972). (In Russian).

A general kinetic equation derived in previous work is considered for limited cases of rarefied systems and weak interacting systems. It was found that in the first case a collision term is Boltzmann-like, but a non-Markovian term is added for spatial nonuniform systems. For the latter term an explicit expression is given. In the second case (in the Markovian approximation) the kinetic equation is reduced to the Landau-like equation and in the Wigner representation the collision term is given with the consideration of the first quantum correction. Linearization of this equation in the model of the test-particle reduces to the Fokker–Planck-like collision term, for which the first quantum corrections are obtained. (auth)

4379 MATRIX ELEMENTS OF A MANY-BOSON HAMILTONIAN IN A REPRESENTATION OF CORRELATED BASIS FUNCTIONS. Wu, F. Y. (Northeastern Univ., Boston). J. Low Temp. Phys.; 9: No. 3-4, 177-87(Nov 1972).

The set of basis functions $\Psi = \psi\Pi_i\rho_{ki}$ in which ψ is a real correlation factor and ρ_k is the Fourier component of the density operator, is useful in describing the ground and low excited states of a many-boson system such as liquid ^{4}He. The problem of computing the matrix elements of the Hamiltonian in this representation is considered. A closed expression is obtained for the general matrix element, and examples that involve the phonon splitting and coalescing states are given. (auth)

4380 q-EQUIVALENT HAMILTONIAN OPERATORS. Razavy, M. (Univ. of Alberta, Edmonton). Can. J. Phys.; 50: No. 17, 2037-47(1 Sep 1972).

From the equation of motion and the canonical commutation relation for the position of a particle and its conjugate momentum, different first integrals of motion can be constructed. In addition to the proper Hamiltonian, there are other operators that can be considered as the generators of motion for the position operator (q-equivalent Hamiltonians). All of these operators have the same classical limit for the probability density of the coordinate of the particle, and many of them are symmetric and self-adjoint operators or have self-adjoint extensions. However, they do not satisfy the Heisenberg rule of quantization, and lead to incorrect commutation relations for velocity and position operators. Therefore, it is concluded that the energy first integral and the potential, rather than the equation of motion and the force law, are the physically significant operators in quantum mechanics. (auth)

4381 SPECTRA OF THE RADIAL EQUATIONS OF DIRAC AND SCHROEDINGER. Obraztsov, V. V. Dopov. Akad. Nauk Ukr. RSR, Ser. A; No. 8, 710-13(Aug 1972). (In Ukrainian).

For definite classes of perturbation potentials q(r) the behavior of the point and continuous spectra of the radial equations of Dirac and Schroedinger is investigated in a neighborhood of the spectral parameter values, respectively $\lambda = \pm m$ and $\lambda = 0$. Characteristics of the behavior of the point and continuous spectra are given in the form of asymptotic expansions. (auth)

4382 FORMULA FOR SEMIGROUP PRODUCT DEFINED BY THE METHOD OF BILINEAR FORMS, AND ITS APPLICATION TO THE SCHROEDINGER EQUATION. Semenov, Yu. A. (Inst. of Theoretical Physics, Kiev). Dokl. Akad. Nauk SSSR; 203: No. 5, 1024-6(11 Apr 1972). (In Russian).

A theorem is presented which allows expansion of the class of potentials for which the Feynman integral with respect to the trajectory converges to the propagator e^{itH}, where H is determined by the method of bilinear forms. The exposition is stated in the general form. (K.S.W.)

4383 SEMICLASSICAL APPROXIMATIONS IN WAVE MECHANICS. Berry, M. V.; Mount, K. E. (H. H. Wills Physics Lab., Bristol, Eng.). Rep. Progr. Phys.; 35: No. 4, 315-97(1972).

A review (completed in February 1972) is presented of various methods of deriving expressions for quantum-mechanical quantities in the limit when ħ is small (in comparison with the relevant classical action functions). One-dimensional problems are treated first, and the derivation of WKB connection formulas (and their reversibility), reflection coefficients, phase shifts, bound state criteria, and resonance formulas are considered, employing first the complex method in which the classical turning points are avoided, and secondly the method of comparison equations with the aid of which uniform approximations are derived, which are valid right through the turning-point regions. The special problems associated with radial equations are also considered. Semiclassical potential scattering is examined next, both for its own sake and also as an example of the three-stage approximation method which must generally be employed when dealing with eigenfunction expansions under semiclassical conditions, when they converge very slowly. Finally, the derivation of semiclassical expressions for Green functions and energy level densities in very general cases is discussed, employing Feynman's path-integral technique and emphasizing the limitations of the results obtained. Throughout the review the fact is stressed that all the expressions obtained involve quantities characterizing the families of orbits in the corresponding purely classical problems, while the analytic forms of the quantal expressions depend on the topological properties of these families. (auth)

REACTOR TECHNOLOGY

4384 (NP–19482) TWENTIETH ANNUAL REPORT FOR THE YEAR ENDED 30 JUNE 1972. (Australian Atomic Energy Commission). 16 Aug 1972. 155p. Dep. NTIS (U. S. Sales Only).

The operations of the Australian Atomic Energy Commission during the fiscal year ending 30 June 1972 are reported. Information is included on: worldwide and Australian developments in nuclear power production; uranium exploration, mining, and enrichment; nuclear fuel requirements; the production and uses of radioisotopes; irradiation services; international activities of the AAEC; and general data on the commission membership, staff personnel, and training facilities. (L.C.L.)

Power Reactor Development

Refer also to abstracts 4733 and 4818.

4385 OVERALL VIEW OF WEST GERMAN NUCLEAR REACTORS. Weckesser, August (RWE-Nuclear Power Plant, Guenzburg, Ger.). Energ. Nucl. (Paris); 14: No. 2, 89-95(1972). (In French).

Technical developments in the field of nuclear power plants in West Germany have been based on the work of private industry and electricity distribution concerns. The fundamental criterion of the work undertaken was to make nuclear energy competitive with energy derived from coal. This criterion favors light-water reactors for the coming years. Pressurized-water and boiling-water reactors having unit capacities up to 1,300 MW(e) are being constructed. It is envisaged that by 1977, nuclear energy will account for 15% of the total energy output. By 1980, the total capacity is expected to be 22,000 MW(e). (France)

4386 ADVANCES IN NUCLEAR SCIENCE AND TECHNOLOGY. VOLUME 6. Henley, Ernest J.; Lewins, Jeffery (eds.). New York; Academic Press, Inc. (1972). 250p. $14.50.

Included are 6 articles on nuclear reactor technology. A separate abstract was prepared for each article. (H.D.R.)

For abstracts of individual papers see: 2648, 4419, 4428, 4442, 4727, and 4790.

4387 REALIZATION OF THE FAST BREEDER REACTOR IS NOW A FACT. THE ORDER FOR THIS BELGIAN–GERMAN–DUTCH PROJECT WILL BE PLACED DURING THIS YEAR. Sandscheper, G. VDI (Ver. Deut. Ing.) Nachr.; 26: No. 14, 2(1972). (In German).

The development of the SNR reactor project is discussed within the framework of the breeder reactor development in Europe, considering costs as well as plans for further tests until the year 1982. (GF)

4388 NUCLEAR ENERGY AND PUBLIC OPINION IN WEST GERMANY. Kempken, M. Energ. Nucl. (Paris); 14: No. 2, 134-8(1972). (In French).

Comments are made on the peaceful exploitation of atomic energy, which began in Germany in 1955. The introduction of nuclear power plants into the German economy is discussed, emphasis being placed on the legal aspects of the problem, the industrial structure, the role of the State, and public opinion. The authorization procedure in the atomic field is briefly reviewed. (France)

4389 NUCLEAR POWER PLANTS CAN GO UNDERGROUND. Rogers, Franklyn C. (Harza Engineering Co., Chicago). Elec. Light Power (Boston); 50: No. 19, 32-5(Oct 1972).

Underground chambers and tunnels have been routine for hydroelectric plants, subways, gas and oil storage and for the convenience and protection of vital operations and the public. Such underground facilities were used mainly when it was economical to do so. Now, the decision to place nuclear power plants underground is motivated by advantages available from an environmental point of view. The environmental as well as layout and cost factors associated with underground nuclear plants are presented. (auth)

4390 CANADIAN NUCLEAR POWER. Grenon, Michel. Rev. Fr. Energ.; 23: No. 241, 359-66(Apr 1972). (In French).

The Canadian reactor system utilizes heavy water, natural U type reactors having pressure tubes: CANDU-PHW, CANDU-BLW, CANDU-OCR. The different plants of the Canadian program, either, already constructed, or currently being constructed, are reviewed: NPD, Douglas Point, the four Pickering and Bruce reactors, and Gentilly. The economic and technical aspects are discussed. AECL and the Canadian industry have together developed an industry for the manufacture of nuclear fuels and the production of heavy water. (France)

4391 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Ackroyd, Ronald Tunstall; Perks, Maurice Arthur (to United Kingdom Atomic Energy Authority). British Patent 1,279,084. 21 Jun 1972. Filed 3 Nov 1969.

Reference is made to core configurations for liquid metal cooled fast breeder reactors. The reactor described employs an upright cylindrical core that includes a central cylindrical breeder region, a fissile region that completely surrounds the central breeder region, and a second fissile region wholly or partially surrounding the first fissile region with axial and radial clearance therebetween. An inner breeder region occupies this clearance, and an outer breeder region extends both axially and radially from the outer boundary of the second fissile region to the cylindrical core boundary. Preferably the second fissile region only partially surrounds the first fissile region, the intervening portions containing breeder material. This enables the annular region between the first and second fissile regions to be entirely breeder, thereby improving the breeding ability and simplifying the design of the structural elements that constitute this region. Such elements, and also those constituting the outer radial breeder, can consist of breeder pins of greater diameter than the fissile pins, since the heat rating of breeder pins is lower than fissile pins, thus enabling a higher breeder/structural material (such as stainless steel) ratio to be achieved. The arrangement can, in a single enrichment core, result in reduced fissile inventory and improved doubling time, while retaining core flattening. The fissile material is preferably UO_2-PuO_2 and the breeder material UC, but the possibility of employing carbides for both purposes is not excluded. The annular region between the first and second fissile regions may be entirely breeder and of full core height. (UK)

4392 REVISED LONG-RANGE PLAN ON THE DEVELOPMENT AND UTILIZATION OF NUCLEAR ENERGY AND ITS UNSOLVED PROBLEMS. Mori, Kazuhisa (Japan Atomic Industrial Forum, Inc., Tokyo). Nippon Genshiryoku Gakkaishi; 14: No. 9, 481-6(Sep 1972). (In Japanese).

The principal items of the revised long-range plan for the development and use of nuclear energy in Japan, published by the Atomic Energy Commission of Japan, are reported. Marked changes that occurred during the 12-month period of deliberation in various aspects of the Japanese economy and developments in nuclear energy have already made some parts of the new long-range plan obsolete, while informal interference from financial authorities before publication caused some of the considerations given to important items to be presented in vague and uncommitting expressions. Information is included on: nuclear environmental policy and rationalization of licensing procedure; technical and human problems associated with wider application of nuclear energy; a demonstration power plant using the advanced thermal reactor; and the urgency of developing a multi-purpose high temperature reactor. (auth)

4393 BREEDER REACTOR PROTOTYPE WILL BE CONSTRUCTED IN KALKAR. STATUS REPORT. Energ. Tech.; 24: No. 4, 142-3(1972). (In German).

The development of the SNR project and plans in conjunction with the breeder reactor development in Europe are discussed. (GF)

4394 RESEARCH AND DEVELOPMENT ON MULTI-PURPOSE HIGH TEMPERATURE GAS COOLED REACTORS. Nozawa, M. (Japan Atomic Energy Research Inst., Tokai). Karyoku Hatsuden; 23: No. 2, 170-4(Feb 1972). (In Japanese).

The preliminary design of an experimental high temperature gas cooled reactor with 50 MW thermal power and outlet gas temperature of 1000°C is described, as well as related research and development. Fuel for this reactor is coated particles of low enriched uranium oxide. Fuel assemblies consist of carbon blocks with inserted fuel pins. The reactor pressure vessel is made of steel. Cooling gas at 1000°C circulates through 3 circuits, one each for iron manufacturing, chemical processing, and electric power generation. Materials which are in contact with the helium gas of 1000°C must be thermostable. Measurement of the effects of control rods and mutual interference among the control rods is expected to be carried out with a semihomogeneous critical assembly. In order to study heat transfer with the high temperature helium gas, a large helium gas loop is being constructed. Various tests are conducted on the domestically manufactured and imported coated fuels. Deposit phenomenon of fission products on metals or carbon is being investigated. Irra-

diation tests in the atmosphere of the high temperature gas cooled reactor are performed with the JMTR. (Japan)

4395 NUCLEAR HEAT GENERATED FROM HIGH-TEMPERATURE REACTORS FOR APPLICATION TO LARGE-SCALE TECHNICAL PROCESSES. Schulten, R.; Kugeler, K. (Kernforschungsanalage, Juelich, Ger.). Min. Wiss. Forsch. Landes Nordrhein-Westfalen-Landesamt Forsch. Jahrb.; 367-400(1970). (In German).

Energy demands for the world and for West Germany are estimated, and the characteristics of various types of reactors and their applications in energy supply are described. The gasification processes (and the utilization of the gasification products and its costs) are described as the most important chance to integrate nuclear power plants in large-scale technical processes. (INIS)

Physics and Core Engineering

4396 (ANL-7967) PARAMETER IDENTIFICATION IN NUCLEAR REACTOR SYSTEMS. Roman, W. S. (Argonne National Lab., Ill.). Sep 1972. Contract W-31-109-eng-38. 93p. Dep. NTIS.

Several techniques are developed for the identification of unknown parameters in lumped and distributive parameter models of nuclear reactor systems. Specifically, a set of algorithms are developed for updating initial parameter estimates by minimizing a least squares criterion function using simulated measurements of the system variables. For the space-dependent-only lumped parameter system, the quasi-linearization technique is shown to be an effective method of identifying parameters in a nonlinear model of a liquid metal fast breeder reactor (LMFBR). In addition to demonstrating the applicability of the quasi-linearization technique to nuclear reactor models, studies were made to illustrate the effect of initial parameter estimates, measurement errors, and number of measurements upon the accuracy of the identification. To identify parameters in a distributive-parameter system, a set of quasi-Newton gradient techniques are shown to be effective methods for parameter identification. The gradient techniques that were analyzed are the Gauss–Newton, conjugate gradient, and variable metric. Results of the analysis showed that the Gauss–Newton technique was superior to the other methods in both accuracy and efficiency. These results were obtained for a time dependent extension of the nonlinear LMFBR model analyzed for the lumped-parameter system, and two linear models of heat transfer and fluid flow processes that are encountered in the analysis of nuclear reactor systems. 71 references. (auth)

4397 (WCAP-7907) LOFTRAN CODE DESCRIPTION. Burnett, T. W. T.; McIntyre, C. J.; Buker, J. C. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). Oct 1972. 86p. Dep. NTIS.

LOFTRAN is a digital computer code which was developed to compute the detailed transient behavior of a one loop pressurized water reactor system. The program simulates the reactor kinetics, reactor control and protection system, safeguard system and other systems and can be used for various accident and control studies. (auth)

4398 ONE-POINT FOUR-GROUP ALGORITHM FOR COMPUTING THE ^{135}Xe AND ^{149}Sm POISONING OF PWR. Apostolov, T. G.; Kolev, N. P. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 25: No. 5, 597-600(1972).

4399 STATISTICAL CHARACTERISTICS OF A BOILING WATER REACTOR IN THE VICINITY OF THE STABILITY LIMIT. Kebadze, B. V.; Plyutinskii, V. I.; Adamovskii, L. A. At. Energ. (USSR); 32: No. 5, 407-8(May 1972). (In Russian).

A simplified dynamic model of a boiling water reactor was examined under conditions whereby non-linearity in the kinetic equations was preserved. Feedback is realized only in terms of steam content during constant pressure. The increment of steam was described as a function of the power increment by a system of linear differential equations for a change in fuel element temperature. The calculations showed that the relative standard deviation of power fluctuations essentially exceeded the amplitude of oscillation calculated without allowing for noise. (K.S.W.)

4400 FUEL BALANCE IN A FAST-REACTOR-BASED NUCLEAR POWER SYSTEM, STARTED UP WITH ^{235}U. Podpora, Jan (Inst. of Nuclear Research, Swierk, Poland). Nukleonika; 16: No. 7-8, 377-88(1971). (In Polish).

New mathematical correlations were derived to calculate the fuel balance in fast reactors fueled with ^{235}U and ^{239}Pu. It was assumed that the fuel of the first charge contained uranium enriched in ^{235}U. The amount of ^{239}Pu was found to increase as a function of time. The calculation was based on a 500 MW(e) reactor with a power density of 0.5 MW/cm^3. Extension of the operation for a period of 20 years revealed the fuel requirements, the produced power and the ^{239}Pu production as a function of time, under four different operating conditions. (TTT)

4401 FURTHER REACTOR PHYSICS STUDIES FOR STEAM GENERATING HEAVY WATER REACTORS. PART 4. A ZERO ENERGY MOCK-UP OF THE 100 MW(e) SGHWR AT WINFRITH. Briggs, A. J.; Johnstone, I.; Newmarch, D. A.; Kendall, K. C. (United Kingdom Atomic Energy Authority, Winfrith, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 3, 215-35(Jul 1972).

A description is given of a comprehensive series of mock-up studies, including power distribution and reactivity measurements, performed in the zero energy reactor DIMPLE using Zircaloy clad SGHWR prototype fuel. These studies provided a wide range of reactor physics data for safety and operational purposes and generally confirmed the calculational routes evolved during previous work with zero energy fuels while drawing attention to isolated areas where more sophisticated methods might be justified when high accuracy is required, e.g., cross channel gradients near reflectors and cross core tilts. (auth)

4402 REAL-TIME SIMULATION OF CORE PERFORMANCE CALCULATION FOR BWR POWER STATION. Miyagaki, Hisanori (Hitachi Ltd., Tokyo); Kishi, Shoichi; Kage, Hakaru; Sugiyama, Sakae; Iida, Hiroshi. Hitachi Hyoron; 20: No. 6, 218-23(Jun 1971).

An on-line core performance calculation system was developed with a view to enhancing economics by reducing the thermal margin while ensuring higher safety at nuclear power plants with boiling water reactors. Using a hybrid simulator, tests were conducted on: (1) program linking, (2) program execution time, and (3) accuracy of performance calculations. As a result, it was concluded that this system can be applied to practical plants with almost no modification. (auth)

4403 PRACTICAL CONTROL PROCEDURES FOR XENON SPATIAL OSCILLATIONS. (VOLUMES I AND II). Bauer, Douglas Clifford. Pittsburgh; Carnegie-Mellon Univ. (1972). 855p. University Microfilms Order No. 72-17,876.

Thesis.

The dissertation conceives, applies, and evaluates practical control techniques for spatial xenon oscillations. It bridges a gap between abstract control theory and real engineering systems by applying techniques which take into active account the capabilities and limitations of the human operator, present detector systems, and control equipment characteristics in practical PWR configurations. Evaluation of alternative control prescriptions is made on the consistent bases of effectiveness and efficiency. The thesis begins with a review of xenon studies, which can be divided into one group concerned with phenomenological design considerations and a second group concerned with control measures to cope with spatial oscillations. Control approaches are divided into analytical and operational subdivisions. This history is the starting point for the research reported in the dissertation. The results of control studies for both constant load and load follow circumstances are reported for alternative control approaches over a wide range of core stability and oscillation size. These studies utilized a comprehensive time-share computer mock-up of a typical PWR system, which enabled realistic operator simulations to be performed. Preferable control techniques that take into account practical system constraints and the implication of imperfect control timing are identified. The effects of depletion on these techniques are also determined from depletion models developed as part of the reported research. Verification of the preferability hierarchy of control techniques is accomplished by a series of independent "operator" simulations and by the results of constant load spatial xenon control tests at the Wisconsin Michigan Electric Company Point Beach Plant. These tests, conducted at 92% power with the Point Beach operators, confirmed the practicality and preferability of First Overtone Control and Overstressed DOC. Preventative and remedial control philosophies are applied to several load follow patterns to develop preferable control approaches for that operational situation. The former philosophy leads to a class of anticipatory control techniques conceived to ameliorate the eventual consequences of load changes on spatial xenon and iodine distributions. Proposals for reshaping spatial xenon distributions by anticipatory control "pre-stressing" are developed to permit defined periods of overload operation without violation of peak local power limits. The implication of depletion on these proposals is drawn. (Diss. Abstr. Int., B)

4404 INFLUENCE OF VARIOUS HYDRODYNAMIC MODELS ON THE CALCULATION OF POWER LEVEL AND TEMPERATURE RESPONSE FOR MILD TRANSIENTS IN FAST ASSEMBLIES.

Peddicord, Kenneth Lee. Urbana, Ill.; Univ. of Illinois (1972). 139p. University Microfilms Order No. 72-19,903.

Thesis.

A study is made to determine the effect of four flow models on power level and temperature calculations for mild transients in liquid metal cooled fast breeder nuclear reactors. The four models considered are bulk flow, slug flow, laminar flow, and turbulent flow. Included also is an investigation of the effect of the various models on the peak centerline fuel temperature and the coolant outlet temperature for the steady state case. The study is made in a fuel pin unit cell consisting of fissionable uranium oxide fuel and stainless steel cladding surrounded by liquid metal coolant. The two-dimensional time dependent problem is reduced to a set of one-dimensional equations by dividing the unit cell into a discrete number of axial segments and averaging the governing system of equations over each axial segment. A linear interpolation scheme is employed to approximate the axial dependence of the temperature in each axial segment. For the steady state problem, the form of the solutions for the radial temperature profiles in each axial segment in the coolant for the slug, laminar, and turbulent flow models is taken to be power series. For turbulent flow, three regions are considered in the coolant: the laminar sublayer region, the near wall or buffer region, and the turbulent core region. By approximating the time derivative in the transient energy equations by a backwards difference scheme, the power series solutions may be extended to the time dependent problem. In addition, solutions of the differential-difference equations for the temperature profiles at each time step in the fuel and cladding are obtained. The time dependent temperature profiles are coupled to the assembly power level. The solutions of the point kinetics formalism may be obtained for a step input of external reactivity. At a subsequent discrete time step, the system power level is determined which allows the calculation of the heat source in the fuel region. The temperature field throughout the unit cell may then be found, and the temperature dependent reactivity feedback, computed. After determining the new total system reactivity, a step change is made to this new level of reactivity, and the calculation proceeds. For the steady state case, the bulk, slug, and laminar flow models predict similar peak centerline fuel temperatures and coolant outlet temperatures. However, due to the radial representation of the model, turbulent flow yields peak centerline fuel temperatures and coolant outlet temperatures which are lower than the quantities resulting from the other three models and a bulk mean coolant outlet temperature which is 4.7% below that predicted by a total energy balance. This result makes itself felt in the transient case by producing less temperature feedback for the turbulent model. The system power level calculated with turbulent flow is greater than that calculated with the other models. (Diss. Abstr. Int., B)

4405 STUDY AND USE OF THE $^{6}Li(n,t)^{4}He$ REACTION, NUCLEAR EMULSIONS, AND SEMICONDUCTOR DETECTORS FOR THE DETERMINATION IN FAST ASSEMBLIES OF NEUTRON SPECTRA ABOVE A FEW keV. De Leeuw-Gierts, G. Brussels; Univ. of Brussels (1968). 156p. (In French).

Thesis.

For the measurement of neutron spectra in fast reactors at zero power, lithium-6 spectrometers, nuclear emulsions, and semiconductor detectors are very promising. The described measurements show a large area of applicability. Interpretations of the spectra E_t and $E_\alpha + E_t$ permit, if the experimental conditions are well studied, determination of neutron spectra from 5 keV to several MeV. Measurements of variation in total count along the central axis of the uranium steel rod demonstrate the usefulness of the reaction $^{6}Li(n,t)^{4}He$ as a test. They also complement the results obtained with integral detectors. (tr-auth)

4406 STAGNANT FLUID DUE TO LOCAL FLOW BLOCKAGE. Ohtsubo, Akira (Power Reactor and Nuclear Fuel Development Corp., Tokyo); Uruwashi, Shinichi. J. Nucl. Sci. Technol. (Tokyo); 9: No. 7, 433-4(Jul 1972).

Control Elements, Systems, and Instrumentation

Refer also to abstract 2632.

4407 (WCAP-7862) ISOLATION TESTS, PROCESS INSTRUMENTATION ISOLATION AMPLIFIER, WESTINGHOUSE COMPUTER AND INSTRUMENTATION DIVISION, NUCANA 7300 SERIES. Garber, I. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). [nd]. 15p. Dep. NTIS.

Four groups of isolator cards, namely, Style Nos. 2837A10G04, 2837A10G06, 2837A12G02, and 2837A12G03 are manufactured by Westinghouse Computer and Instrumentation Division. Style Nos. 2837A10G04, 2837A12G02, and 2837A12G03 were tested at normal ambient temperature for isolation characteristics. The isolator assemblies tested maintained input circuit integrity (protection circuit) for all disturbances applied to the common mode of the output circuit. In some cases, the output stage was damaged by the applied disturbance, but the protection circuit remained functional and within design accuracy limits. Although Style No. 2837A10G06 was not tested, the test results obtained for Style No. 2837A10G04 are applicable to Style No. 2837A10G06 based on the fact that the damage occurred only in the output stage. (auth)

4408 NUCLEAR POWER PLANT AUTOMATION AND DISCRETE DRIVE CONTROL SYSTEMS. Emel'yanov, I. Ya.; Voskoboinikov, V. V.; Perfil'ev, V. P. At. Energ. (USSR); 33: No. 3, 735-9(Sep 1972). (In Russian).

Certain problems associated with the use of discrete control systems in automated nuclear power plants are considered. The advantages of discrete systems operating in conjunction with digital computers are shown. Discrete drive control circuits are presented. The main types of discrete drives used in modern reactor engineering, their basic design features, and data obtained during operation in nuclear reactor are included. (auth)

4409 STATISTICALLY OPTIMUM CONTROL OF FAST-REACTOR PULSE ENERGY. Popov, A. K. This paper was summarized in At. Energ. (USSR); 31: No. 3, 269(Sep 1971) as paper No. 523/4894. (In Russian).

Full copy of this paper is held by TIC.

The problem of optimizing the control algorithm of an automatic controller system minimizing the rms deviation of e_k from the preset power output level E^* for an oncoming future pulse is posed in the statistical sense, on the basis of information obtained in the preceding pulses: $e_k = \exp\{s_k + B(u_k + \mu)\} - 1$, where e_k, u_k, and s_k are respectively the relative deviations in the energy, reactivity brought about by the automatic controller, and the intensity of the sources of delayed neutrons, from their base reference values E^*, ϵ_m^*, S^*. Here s_k is expressed in terms of values of the energies of the preceding pulses, while μ is the generalized random noise (reduced to the reactivity) due to reactivity fluctuations, to the statistical nature of nuclear processes, to instability in the speed of rotation of the moving part, and so on. (auth)

Containment Systems, Shielding, Waste Processing, and Radiation Protection

4410 (CONF-721018-4) LMFBR RADIATION TRANSPORT METHODS DEVELOPMENT. Mynatt, F. R.; Gritzner, M. L.; Williams, L. R.; Clifford, C. E. (Oak Ridge National Lab., Tenn.). 1972. 19p. Dep. NTIS.

From fourth international conference on reactor shielding; Paris, France (9 Oct 1972).

The elements of a shielding program based on a fundamental approach are discussed with a brief evaluation of the present status of the technology. A procedure is presented for utilizing the best features of Monte Carlo, discrete ordinates, and diffusion theory in coupled calculations providing good accuracy at minimum expense. As an example, results are presented from a four-step coupled two-dimensional discrete ordinates calculation for determination of the neutron and secondary gamma-ray dose rates in the FTR head compartment. An assessment of computational methods development plans is presented. (40 references) (auth)

4411 (RDT-E-2-3-T) REACTOR VESSEL FOR LIQUID METAL SERVICE. (Division of Reactor Development and Technology (AEC), Washington, D. C.). Oct 1972. 27p. RSO.

The requirements for reactor vessels for reactor systems with loop-type sodium cooling that are constructed in accordance with the Class 1 requirements of the ASME Boiler and Pressure Vessel Code, Section III (hereinafter referred to as the Code), and supplementary requirements that are additive or more restrictive, are delineated. (auth)

4412 PRESENT STATE OF INSTALLATION OF FILTERS FOR REACTOR USE IN BWR POWER. Sawaguchi, Y. (Tokyo Electric Power Co. Inc.). Kuki Seijo; 8: No. 7, 12-14(Mar 1971). (In Japanese).

Filters for reactor use installed in BWR power plants include high efficiency particle filters to remove solid fission products from off gas, iodine filters and high efficiency particle filters placed in the emergency gas treatment system and used in loss of coolant accident to process fission products leaked from containment vessels to reactor houses, charcoal filters to clean up central control room atmosphere in case of accidents and so on. The emergency gas treatment system and the filters used in the

system are described. Guaranteed system efficiency for iodine removal is 97% under humidity less than 80%. However actual efficiency is expected to be above 99%. (Japan)

4413 LEAK RATE TEST ON NUCLEAR REACTOR CONTAINMENT VESSEL. Kaneda, A. (Mitsubishi Heavy Industries, Ltd., Tokyo); Kamisako, M.; Masaki, T.; Katayama, M.; Satake, M. Mitsubishi Juko Giho; 8: No. 3, 252-63(Oct 1971).

A leak rate test was conducted on the No. 1 nuclear reactor containment vessel installed at the Mihama Power Station. This is the first test in Japan to be performed by the absolute method which was approved on the basis of test results obtained at the time of completion of the vessel. The details of those test results are described. These results confirmed that the containment vessel leak rate at the design pressure (2.39 kg/cm^{2}G) was about 0.02$_2$%/24h, which was far less than the allowable leak rate of 0.1%/24h. Also it was found that because the containment vessel is surrounded by an exterior shield concrete wall, there was a great error in measured leak rate when the vessel was heated by the sun during the daytime. This error could be eliminated effectively by spraying water on the top of the vessel. Also that leak rate could be calculated with sufficient accuracy by using the values measured during midnight to dawn, in which case spraying of water was not necessary. (Japan)

4414 CONTAINMENT SYSTEM FOR LARGE CAPACITY PWR PLANTS. Sato, K.; Otoda, T. (Mitsubishi Heavy Industries, Ltd., Kobe, Japan). Karyoku Hatsuden; 23: No. 1, 45-53 (Jan 1972). (In Japanese).

Various merits of using ice condensers in the containment system of large PWRs are emphasized. The construction schedule for PWRs in Japan is explained with emphasis upon the scale-up of power output. Four types of containers are described. These types are classified as "dry type" and "ice condenser type". The former confines blow-down energy within the containers, whereas the latter absorbs it and is desirable for large scale plants. For example, in a 1200 MWe plant, use of the "ice condenser type" reduces the design pressure and volume of the containers to $\frac{1}{3}$ and $\frac{1}{2}$ respectively of the design pressure and volume of conventional "dry type containers". The structure and function of the ice condensers are discussed in detail. The kinetic behavior of inner pressure in the case of pipe rupture is also shown. Finally, outstanding features of the ice condensers are summarized as follows: size of containers can be made small; structure is simple and reliable; environmental effect of radioactivity in case of accident can be further reduced; and auxiliary equipment required for safety operation can be simplified. (Japan)

4415 CONTAINMENT SPRAY EXPERIMENTS WITH THE PSICO 10 FACILITY. Guerrini, B.; Lanza, S.; Mazzini, M.; Mirandola, R. (Univ., Pisa, Italy). Energ. Nucl. (Milan); 19: No. 7, 444-58(Jul 1972).

Six experimental runs on molecular iodine removal by containment sprays were carried out in the 100 m^3 PSICO 10 model containment vessel. The containment atmosphere, previously cleaned up by absolute filters, was a steam-air mixture initially at 65 to 85°C and 1.3 to 1.7 atm. Both water and water with 1% sodium thiosulphate addition were used as spray solutions at temperatures ranging from room to containment atmosphere temperature. The experimental results of these tests are presented and analyzed. 14 references. (auth)

4416 EQUIPMENT FOR SUPPORTING A NUCLEAR REACTOR VESSEL. Costes, Didier (to Commissariat a l'Energie Atomique). French Patent 2,096,874. 3 Mar 1972. Filed 9 Jul 1970. (In French).

A supporting structure for an integrated type fast sodium-cooled nuclear reactor is described. This structure fixes the principal vessel to its concrete envelope with a skirting having a thermal gradient, the temperature gradient inside the skirting being simultaneously improved and the volumetric gas coverage being increased. The principal vessel, which is filled with a coolant liquid, is mounted on a cold slab and is supported by a cylindrical skirting having a slightly larger diameter. A sealed joint is effected between the upper part of this skirting and the vessel and its lower part at the peripheral edge of the cavity containing the vessel. This vessel, which is enlarged in its upper part, thus provides a large annular space for the gas coverage. The space between the principal vessel and the cavity which is limited by the skirting may be evacuated in order to insulate the vessel. (France)

Cooling Systems

Refer also to abstracts 2626 and 2627.

4417 (ORNL-MIT-117) REMOVAL OF TRITIUM FROM THE MOLTEN SALT BREEDER REACTOR FUEL. Shapiro, M. D.; Reed, C. M. (Massachusetts Inst. of Tech., Oak Ridge, Tenn. (USA). School of Chemical Engineering Practice). 18 Nov 1970. 33p. Dep. NTIS.

Molten Salt Breeder Reactors will produce large quantities of tritium which can permeate most metals at elevated temperatures and thereby contaminate the environment. In this project it was assumed that the tritium can be removed from the salt stream by a hydrogen-helium purge and that the helium can be separated for recycle with a palladium membrane. Several systems for concentrating and storing the tritium were conceptualized, designed, and economically evaluated. Cryogenic distillation of liquid hydrogen appears to be the most economical system. A cryogenic system with a capacity of 4630 gmoles of hydrogen per hour at a 1000-fold tritium enrichment has an estimated capital cost of $328,000 and an estimated annual operating cost of $81,000 (excluding depreciation). (25 references) (auth)

4418 (ORNL-TM-3956) DESIGN AND PROCUREMENT GUIDE FOR PRIMARY COOLANT PUMPS USED IN LIGHT-WATER-COOLED NUCLEAR REACTORS. (Oak Ridge National Lab., Tenn. Franklin Inst. Research Labs., Philadelphia, Pa. Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.). Nov 1972. Contract W-7405-eng-26. 433p. Dep. NTIS.

Information related to the design and operation of primary coolant pumps used in light-water-cooled nuclear reactor systems is presented in this document. General requirements for the operation and performance of primary coolant pumps are discussed, and the major components of these pumps, their functions, and their design features are described in detail. The materials and methods used in the fabrication and assembly of these pumps are discussed, and recommended quality control, inspection, and maintenance procedures are described. Up-to-date design information and example calculations that can be used by the purchaser to evaluate the relative merits of reactor coolant pumps are also presented. 37 references. (auth)

4419 HEAT TRANSFER IN LIQUID-METAL COOLED FAST REACTORS. Sesonske, Alexander (Purdue Univ., Lafayette, Ind.). Advan. Nucl. Sci. Technol.; 6: 175-201(1972).

The heat transfer characteristics of liquid metal cooled fast breeder reactors and their effects on reactor design procedures are reviewed. The various aspects of thermal analysis of fast reactor fuel elements, heat transfer limitations, and safety are discussed, and the pool and loop designs of heat transport systems are described. 26 references. (H.D.R.)

4420 DEVELOPMENT PROBLEMS OF STEAM GENERATORS IN THE CONTEXT OF THE FUTURE DEVELOPMENT OF NUCLEAR POWER PLANTS. Hryniszak, W. (Clarke, Chapman and Co. Ltd., Gateshead, Eng.); Bitterlich, E. Mitt. Ver. Grosskesselbetr.; 51: No. 6, 444-54(1971). (In German).

A fundamental introduction is followed by a description of the development of steam generators for British gas-cooled reactors mainly concentrated on AGR-type reactors. Supported by prominent examples a description is given on the constructive features as well as on materials problems. (GF)

4421 PRE-STRESSED CONCRETE REACTOR VESSEL TIME-SAVING ULTIMATE LOAD ANALYSIS. Bangash, Y. (Thames Polytechnic, London). J. Inst. Nucl. Eng.; 13: No. 4, 108-10; 115-16(Jul 1972).

An attempt is made to predict graphically the ultimate gas load that prestressed concrete reactor vessels can withstand. The vessels are of cylindrical shape with barrel walls and flat top and bottom caps. Top caps are perforated to receive fuel stand pipes through which a charge machine feeds the reactor. From boilers and circulators in the vessel, the gas increases its pressure, which causes the vessel to deform. In order to counteract this effect the vessel is externally prestressed in such a way as to minimize the stresses caused by the gas load and to bring down to permissible values in concrete. The scope is restricted to the following prestressing layout: Vertical prestress is provided by longitudinal tendons. Circumferential prestress is provided by strands or wires wound in several layers in a series of circumferential troughs formed in the wall and cap. A common failure mode described is based on experimental work. (auth)

4422 NONLINEAR ANALYSIS OF SOLID STRUCTURES. Saugy, B.; Zimmermann, Th. Ann. Inst. Tech. Batiment Trav. Publics; No. 292: 125-43(Apr 1972). (In French).

In order to analyze the behavior of solid structures and to calculate their failures, a finite element calculation program was developed. This program takes into consideration the principal nonlinearities intervening when normally used materials are subjected to increasing loads until the structure collapses. The analysis by the displacement method (a method based on the finite element method) is adapted to the nonlinear deformation model

utilizing an iterative process. In this way, it was possible to determine the stress and strain distributions with a fixed external load. The model established for the deformation on the basis of tests carried out on concrete and various soils includes a nonlinear isotropic stress-strain relation limited by a failure surface. A simple expression derived from tests is given for this surface. Beyond this surface, the fissured material is represented by an anisotropic model oriented in relation to the cracks. The bulking of the granular materials can be taken into consideration by introducing a certain expansion defined in terms of the loads. Certain calculations are compared with the results obtained in laboratory tests, particularly for the prestressed concrete pressure vessels of fast neutron reactors. (France)

4423 MAXIMUM SUPERHEATING OF SODIUM DURING EFFERVESCENCE. Leonov, A. I.; Prisnyakov, V. F. (Dnepropetrovsk State Univ., USSR). High Temp. (USSR) (Engl. Transl.); 10: No. 1, 124-7(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 149-52(1972).

Superheating of sodium at 480–510°C was measured by various methods of deactivation of the surface during boiling in tubes of steel 1Kh18N9T. The stable limit of superheating found, which is much lower than that determined by the Dering–Folmer formulas, is approximated by an empirical linear dependence. The absence of the effect of wall roughness and contact time of sodium with the surface on the maximum superheating is shown, and the probability of the occurrence of maximum superheating in an unstable boiling regime is determined. (14 references) (auth)

4424 ANISOTROPIC IN-REACTOR SAG OF PRESSURE TUBES. Holicky, M.; Schroeder, J. (Univ. of Waterloo, Ont.). J. Basic Eng.; 94: No. 2, 369-72(Jun 1972).

A basic solution for in-reactor sag of horizontal pressure tubes is proposed in accordance with a nonlinear anisotropic creep theorem. As an example, numerical solutions for in-reactor sag of cold-worked Zircaloy-2 pressure tubes supported at the ends only are given for various combinations of anisotropy coefficients. It is shown that an isotropic analysis may overestimate or underestimate the deflection due to sag by about 100% if hoop creep rates are about 50% smaller or larger than longitudinal creep rates. (auth)

4425 APPARATUS FOR HEAT EXCHANGE BETWEEN LIQUID METALS. (to Societe Babcock-Atlantique). French Patent 2,096 970. 3 Mar 1972. Filed 22 Jul 1970. (In French).

A heat exchanger system intended to be integrated into the vessel of a liquid metal (Na) cooled nuclear reactor is presented. The assembly functions as an intermediate exchanger in which the heat from the heated primary Na is transferred to the nonradioactive secondary Na. The device possesses an envelope which forms an elongated circulation chamber for one of the metals. A system of tubes is contained inside this envelope. The tubes are joined to the inlet and outlet pipes by tubular plates. The essential characteristics of this type of exchanger are that these tubes are wound in a helical configuration and are connected to the plates by rectilinear inlet and outlet pieces, which are parallel to the axis of the chamber and grouped about its center. (France)

4426 INCIPIENT BOILING PHENOMENA OF SODIUM UNDER FORCED CONVECTION BY DIRECT HEATING. Takahashi, K.; Fujii-e, Y.; Suita, T. (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 10, 603-12(Oct 1972).

The results of an experimental study on incipient sodium boiling with upward forced convection loop are reported. Forced convection sodium in a vertical tube of 14.9 mm I.D. was directly heated by direct current (~4 V, ~5,000 A). The experiments were carried out under the following conditions: input power from 6 to 12 kW with pressure at the condenser from 0.9 to 1.1 atm; flow rate from 1.0 to 3.0 l/min with inlet temperature from 7,500° to 830°C. The incipient boiling phenomena observed were either violent single bubble ejection or else slow vapor formation depending on the conditions. It was indicated from observations of the position of boiling inception that the boiling did not always occur at the position of maximum temperature. (14 references) (auth)

Fuel Systems and Components

Refer also to abstract 3025.

4427 (GEAP-13864) TRITIUM ANALYSIS OF MIXED-OXIDE FUEL RODS IRRADIATED IN A FAST FLUX. Wozadlo, G. P.; Rubin, B. F.; Roy, P. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). Aug 1972. Contract AT(04-3)-189. 18p. Dep. NTIS.

Tritium distributions were determined for the fuel, cladding, and fission gas of four stainless steel clad, mixed oxide fuel rods irradiated in a fast flux. The average fuel burnup ranged from 46,000 to 79,000 MWd/Te at average powers of 11 to 14 kW/ft. The result of this study showed that less than 1% of the tritium produced was retained in the fuel. Little or no tritium was found in either the cladding or fission gas. The majority of the tritium produced in the fuel will be released to the primary system coolant and a portion of this tritium will eventually find its way into the reactor cover gas. A preliminary estimate indicated the partial pressure of tritium in the cover gas will be 2 to 5 times that of hydrogen, or 0.5 to 1.0×10^{-9} torr during steady-state operation at a cold trap temperature of 121°C (250°F). (auth)

4428 QUANTITATIVE DESCRIPTION OF DEFORMATION AND STRESS IN CYLINDRICAL FAST REACTOR FUEL PINS. Matthews, J. R. (Atomic Energy Research Establishment, Harwell, Eng.). Advan. Nucl. Sci. Technol.; 6: 65-104(1972).

The mathematical techniques used in calculations of reactor fuel element behavior are reviewed, the assumptions and data used in their construction are examined, and the main features peculiar to fast systems are outlined. Only normal operation conditions are considered and emphasis is on the mechanical behavior of the fuel elements. 91 references. (H.D.R.)

4429 HEAT TRANSFER AND PRESSURE DROP PERFORMANCE OF A SURFACE ROUGHENED BY SMALL SQUARE RIBS. Kimpton, A. D.; Lyall, H. G. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 3, 271-7(Jul 1972).

Results are presented for heat transfer and pressure drop tests on a stainless steel rod mounted concentrically in a smooth, circular channel. The rod was roughened by small, square, transverse ribs formed integral with the surface. The results agree well with those of previous work. When these results are transformed in what appears to be the physically most meaningful manner, they give a performance considerably below that of some published correlations for rough surfaces. The reason for this discrepancy are that the correlations are based on experimental data transformed by a method now seen to give optimistic results. They are based on results using high conductivity surfaces instead of stainless steel, and the correlations make no allowance for Reynolds number effects. It is shown from previous results that for stainless steel surfaces increasing the rib height gives little if any improvement in performance. A substantial improvement does appear possible using surfaces of the type developed previously. However these high performance surfaces require much more material in the ribs, making them unsuitable for use in thermal reactors because of the resulting extra neutron absorption. (auth)

4430 FLOW DETERMINATIONS IN THE DEAD WATER BEHIND LOCAL BLOCKAGES IN COOLING CHANNELS OF ROD BUNDLES. Basmer, P.; Kirsch, D.; Schultheiss, G. F. (Kernforschungszentrum, Karlsruhe, Ger.). Atomwirt., Atomtech.; 17: No. 8, 416-18(Aug 1972). (In German).

A fuel element model was constructed with the geometry of an SNR fuel element which possesses a hexagonal distribution of rods. Water with fine air bubbles was pumped through the model, and was observed through a lucite window either visually or cinematographically. Blockage restricted the flow cross section by 41%. Results showed that blockage generated a recirculation current with quasistationary vortex in the dead water. Schematically presented are experimental setup and flow patterns. (H.B.G.)

4431 RESTRAINT OF FAST REACTOR SUB-ASSEMBLIES AGAINST VOIDAGE-INDUCED BOWING. Collinge, I. R. (Oxford Univ.). J. Brit. Nucl. Energy Soc.; 11: No. 3, 251-7(Jul 1972).

The principles of the restraint of fast reactor subassembly bowing against voidage-induced bowing are discussed from a theoretical viewpoint. The importance of irradiation creep, thermal creep and restraint positioning is assessed with the aid of a simple model. (auth)

4432 OUTLINE OF THE JAPAN EXPERIMENTAL FAST REACTOR "JOYO". 1. FUEL HANDLING FACILITY. Kinoshita, M.; Ueno, M.; Morishita, K. (Fuji Electric Co. Ltd., Tokyo). Fuji Jiho; 45: No. 3, 344-50(Mar 1972). (In Japanese).

"Joyo" is a sodium cooled fast breeder reactor loaded with mixed oxide fuels of plutonium and uranium, and has a thermal power of 100,000 kW. The fuel exchange in "Joyo" is performed during suspension of the reactor operation and by keeping the temperature and flow of primary coolant at 250°C and 650 tons/h, respectively. The spent fuels are temporarily stored and cooled in the in-core storage rack, and they are taken out from the reactor core and washed, canned and stored and cooled in water pool

and carried out. The main fuel handling machines are preserved in an atmosphere of argon gas. The in-core refueling machine exchanges individual fuel elements one by one between reactor core and in-core storage rack. The fuel loading and unloading machine transfers individual fuel elements between an in-core storage rack and a transfer rotor. The transfer rotor relays the fuel between the fuel loading and unloading machine and the fuel handling cask car. The gripper washing facility washes the radioactive sodium attached to the gripper of refueling machine. Other equipment is discussed, such as the fresh fuel storage facility, spent fuel canning facility, spent fuel storage facility, argon gas facility, and measurement equipment. These machines are going to be manufactured in accordance with a schedule for emplacement of the reactor in Feb. 1974. (Japan)

4433 REVIEW OF STAINLESS STEEL PROPERTIES FOR FAST REACTOR FUEL ELEMENTS. Board, J. A. (British Nuclear Design and Construction Ltd., Whetstone). J. Brit. Nucl. Energy Soc.; 11: No. 3, 237-49(Jul 1972).

Important properties which dictate the performance of cladding and wrappers for fast reactor fuel elements are radiation hardening, loss of ductility, yield strength of irradiated stainless steel, irradiation creep, and irradiation induced voidage swelling. These aspects are considered in some detail. In addition, corrosion effects, such as interaction of cladding with fuel, are examined. 77 refs. (UK)

4434 POTENTIAL OF A CIRENE REACTOR FUELLED WITH URANIUM METAL. Bozzola, S.; Genova, M.; Lombardi, C.; Zorzoli, G. B. (CISE, Milan). Energ. Nucl. (Milan); 19: No. 7, 433-43(Jul 1972).

A preliminary study is reported on the characteristics of a CIRENE reactor fueled with uranium metal. It clearly shows the significant benefits of this solution with respect to a conventional UO_2 fueled CIRENE reactor, both from the economic and operational standpoint. A conservative 0.2 mills/kWh saving in the energy cost is surely possible, but a 0.4 mills/kWh value is not beyond imagination. As for design, acceptable solutions can be hopefully found for the only real problem, i.e., scarce uranium compatibility with water. Further research, however, is needed to reach a firm convincement to this regard. 18 references. (auth)

Auxiliary Systems, Protection Systems, and Engineered Safeguards

Refer also to abstracts 3019, 3020, and 3022.

4435 (DOCKET-50293-99) PILGRIM NUCLEAR POWER STATION. Unusual Occurrence UO-72-1. (Boston Edison Co., Mass.). 17 Oct 1972. 2p. Dep. NTIS.

The leakage of torus water through check valves in the high pressure coolant injection turbine exhaust drain line is reported. (H.D.R.)

4436 (DOCKET-50293-100) PILGRIM NUCLEAR POWER STATION. Unusual Occurrence UO-72-2. (Boston Edison Co., Mass.). 17 Oct 1972. 1p. Dep. NTIS.

The failure of the motor for one of the low pressure coolant injection system valves is reported. (H.D.R.)

4437 (DOCKET-50293-101) PILGRIM NUCLEAR POWER STATION. Unusual Occurrences UO-72-3, UO-72-4, and UO-72-5. (Boston Edison Co., Mass.). 24 Oct 1972. 5p. Dep. NTIS.

The occurrence of a grounding problem on the "A" 125 volt dc battery bank and the failure of a motor on the reactor cleanup system isolation valve are reported. A valve motor failure on the high pressure coolant injection system is described. (H.D.R.)

4438 EMERGENCY CORE COOLING OF THE AEG BOILING WATER REACTORS. Koch, E. Waerme; 78: No. 1-2, 3-7(1972). (In German).

The emergency core cooling system is the most important safety system for a nuclear reactor. It removes the after-heat in the unlikely case of a coolant accident. Several coolant circulation systems are explained and the emergency cooling is discussed for the modern BWR-type reactors with internal coolant circulation pumps. Owing to the favorable design of the boiling water reactors it is possible to keep the nuclear core covered with coolant during a loss-of-coolant accident. It is concluded that this core cooling system guarantees an even better performance than the new ECCS-criteria demand. (GF)

4439 OUTLINE OF THE JAPAN EXPERIMENTAL FAST REACTOR "JOYO". 2. RADIATION MONITORING AND MISCELLANEOUS FACILITIES. Kinoshita, Makoto; Maekawa, Y.; Etoh, Fukuo; Kobayashi, K.; Morishita, K. (Fuji Electric Co. Ltd., Tokyo). Fuji Jiho; 45: No. 4, 419-27(Apr 1972). (In Japanese).

The experimental fast reactor "Joyo" is a sodium cooled breeder reactor under construction. It is scheduled to reach its criticality in 1975. Radiation monitoring facilities and other facilities at "Joyo," except the fuel handling ones, are described. The radiation monitoring is classified into fixed monitoring and individual monitoring. The fixed monitoring consists of area monitoring, radioactive dust and gas monitoring, and field monitoring. Data from fixed monitoring will be computer processed. The area monitor consists of a gamma ray monitor and neutron monitor. The field monitoring is divided into the released gas monitoring and the liquid effluent monitoring. The electric power supply system is composed of a general system, emergency system, and non-interruption system. The emergency system is expected to supply power by automatic starting of Diesel electric generators, which are connected to important facilities such as the reactor isolation system, safety and protection system, and the reactor protection system. The non-interruption system consists of two sets of direct current supply systems and two sets of alternating-current systems. The treatment plants for treating radioactive wastes handle the gaseous, liquid, and solid radioactive wastes separately. Other equipment is introduced, such as the supply systems for sodium, argon gas, nitrogen gas, in-core inspection equipment, and air conditioners for the attached buildings. (Japan)

4440 NEW TEST SYSTEM DEVISED FOR NUCLEAR POWER PLANTS. Mater. Eval.; 30: No. 10, 59A(Oct 1972).

The Automated Reactor Inspection System (ARIS) is described which employs computer-controlled ultrasonic equipment for in-service detection of defects and fatigue cracks in nuclear power plant components including the reactor, pressure vessel, and coolant system. (L.C.L.)

4441 GAS PURIFICATION IN HELIUM-COOLED NUCLEAR REACTORS. Ewald, R. (Messer Griesheim GmbH, Frankfurt am Main); Schwier, K. Chem.-Ing.-Tech.; 44: No. 19, 1105-9 (Oct 1972). (In German).

An adsorption process for the removal of carbon dioxide, krypton, xenon, and nitrogen from the cooling circuit of helium-cooled nuclear reactors is described. Krypton and xenon are radioactive. Depending upon the operating conditions (normal operation, interrupted operation with increased accumulation of carbon dioxide or nitrogen) there are three variants of the process, which, if necessary, can be used in combination. The process was developed with special consideration of compact construction, limitation of radioactivity to a few parts of plant, and avoidance of greater thermal stresses during operation. (auth)

Operation and Economics

Refer also to abstract 3023.

4442 IMPACT OF FUEL CYCLE ECONOMICS ON THE FUTURE DEVELOPMENT OF NUCLEAR POWER. Went, J. J.; Wiechers, W. K. (KEMA, Arnhem, Netherlands). Advan. Nucl. Sci. Technol.; 6: 203-30(1972).

The effects of development and utilization of specific reactor types on future fuel cycle expenditures are examined. The study is limited to Western Europe and analyzes, in particular, the effects of fast and thermal breeder utilization on fuel cycle costs. 11 references. (H.D.R.)

4443 IN CORE FUEL MANAGEMENT STUDIES OF LARGE FAST REACTORS. Stoll, Harry Gene. Urbana, Ill.; Univ. of Illinois (1972). 149p. University Microfilms Order No. 72-19,938.

Thesis.

Optimization techniques applicable to in-core fast reactor fuel management are developed. The development of these computational techniques begins with problems involving burnup independent continuous controllers and proceeds to burnup dependent continuous controllers and finally to burnup dependent noncontinuous controllers. The techniques which evolve from the study are quasilinear gradient techniques coupled to branch and bound techniques. A one dimensional reactor model for refueling is developed in which the variables to be optimized are the number and position of fresh feed assemblies and the shuffling configuration of partially irradiated assemblies. The constraints upon the reactor fuel are that it supply the demanded energy, conform to the reloading schedule, and not violate any peak power or peak burnup limitations. (Diss. Abstr. Int., B)

4444 PERIODICAL INSPECTION OF TSURUGA NUCLEAR PLANT. Maekawa, N. (Japan Atomic Power Co., Tokyo). Karyoku Hatsuden; 23: No. 1, 33-7(Jan 1972). (In Japanese).

Programs for and the results of periodic inspections in the Tsuruga nuclear plant are described. The first periodic inspection began on Oct. 1, 1970 and was expected to require 60 days but was finished on Nov. 13. From May to June 1971 the reactor was shut down for removing poison curtains from the reactor core. At this time, in-service inspection of the pressure boundaries of the reactor coolant was performed. The second inspection began at the end of Sept. 1971 and is progressing smoothly. Forty new fuel elements were loaded, and the remaining poison curtains were removed. During the third inspection in 1972, 70 new fuel elements are scheduled to be loaded. In scheduling time for the periodic inspections, fuel cycle, seasonal electric power demands, and management of power supply must be considered. All equipment is under the influence of radioactivity. Therefore, prevention of abnormal exposure of the workers, protection against internal radiation exposure, and prevention of outflow of contamination from controlled areas must be considered during the periodic inspections. (Japan)

Safety and Siting

4445 (CONF-721109–2) INTERPOLATIONAL SCHEME FOR MONITORING THE REFUELING OPERATIONS IN AN LMFBR. Buhl, A. R.; Rhoades, W. A.; Bartine, D. E. (Oak Ridge National Lab., Tenn.). [nd]. 5p. Dep. NTIS.
From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

An interpolational scheme for monitoring the refueling operations in a LMFBR is presented. Available information from the low-level flux monitoring system is related to the reactive slate of the system through the modified source multiplication (MSM) method and inexpensive calculations. (J.M.J.)

4446 (ORNL-NSIC–74) CALCULATION OF DOSES DUE TO ACCIDENTALLY RELEASED PLUTONIUM FROM AN LMFBR. Fish, B. R.; Keilholtz, G. W.; Snyder, W. S.; Swisher, S. D. (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 123p. Dep. NTIS.

Experimental data and analytical models that should be considered in assessing the transport properties of Pu aerosols following a hypothetical reactor accident have been examined. Behaviors of released airborne materials within the reactor containment systems, as well as in the atmosphere near the reactor site boundaries, have been semiquantitatively predicted from experimental data and analytical models. The fundamental chemistry of Pu as it may be applied in biological systems has been used to prepare models related to the intake and metabolism of PuO_2, the fuel material of interest. Attempts have been made to calculate the possible doses from Pu aerosols for a typical analyzed release in order to evaluate the magnitude of the internal exposure hazards that might exist in the vicinity of the reactor after a hypothetical LMFBR (Liquid-Metal Fast Breeder Reactor) accident. Intake of Pu (using data for ^{239}Pu as an example) and its distribution in the body were treated parametrically without regard to the details of transport pathways in the environment. To the extent possible, dose-response data and models have been reviewed, and an assessment of their adequacy has been made so that recommended or preferred practices could be developed. 157 references. (auth)

4447 (ORP/SID–72-4, pp 87-101) PWR NUCLEAR POWER PLANT SYSTEMS FOR REDUCING RADIOACTIVE RELEASES. Von Hollen, H. J. Sep 1972.
From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

An advanced Pressurized Water Reactor power plant design is presented which represents an integrated systems approach to the control of reactor effluents within the plant and the eventual processing of plant effluents and which results in a substantial reduction in the amount of radioactivity released to the environment. Process diagrams for the chemical and volume control system using boron thermal regeneration, the waste gas system, and the waste liquid system are included. (L.C.L.)

4448 TRENDS IN THE DEVELOPMENT OF SPECIAL REACTOR SAFETY CRITERIA. Lindackers, K.-H. (Technischer Uberwachungs-Verein Rheinland e. V., Cologne). Atomwirt., Atomtech.; 17: No. 8, 428-30(Aug 1972). (In German).

Criteria for safety of nuclear power plants should be established in such a way that the operational risk is minimal and independent of environmental conditions. Although standardization shows some beginning, the technical safety requirements urgently need a unified system of generally applicable directives. With respect to emission of radioactive material, limits are already established. Needed are directives with respect to earthquakes, external impacts, and reliability of reactor protection systems. (H.B.G.)

4449 CONSIDERATION ON THE GROWTH OF A SINGLE SODIUM BUBBLE IN A FBR CHANNEL. Takahashi, Ryoichi (Tokyo Inst. of Tech.)· Matsuoka, Yoshinori; Shindo, Masuo; Yokozawa, Hiroyuki. Bull. Tokyo Inst. Technol. (Engl. Ed.); No. 109, 33-9(Mar 1972).

It is important to understand the development of a sodium bubble in a channel from the safety view point of fast breeder reactors. A single piston-type bubble is investigated numerically. Its behavior depends on the thickness of the initial residual film at the heated wall. Oscillatory behavior of a sodium bubble results mainly from the cooler region of the core (e.g., upper blanket). (auth)

4450 UNCERTAINTY AND RISK IN NUCLEAR POWER PLANT DESIGN. Weisman, Joel (Univ. of Cincinnati). Nucl. Eng. Des.; 21: No. 3, 396-405(1972).

Nuclear power plant design consists of capability, reliability, and safety analyses. None of these analyses should be carried out under deterministic conditions but rather under risk or uncertainty. It is concluded that the capability analyses should be conducted under conditions of risk, reliability analyses under risk or uncertainty, and safety analyses under uncertainty. Design approaches are proposed for each of these situations. 25 references. (auth)

4451 UNITIZED CONCEPT FOR EARTHQUAKE-RESISTANT NUCLEAR POWER PLANTS. Finke, J.; Lin, M. S. (Kaiser Engineers, Oakland, Calif.). Nucl. Eng. Des.; 21: No. 3, 406-20(1972).

A unitized concept for an earthquake-resistant nuclear power plant which can withstand major earthquake shaking and fault slips without releasing radioactive material into the atmosphere is discussed. A 1000 MW(e) pressurized water reactor power plant of recent design is adapted to a unitized concept, and cost studies are made for the incremental cost. 9 references. (auth)

4452 ANALYSIS OF INERTIAL CONTRIBUTION OF THE FLUID IN A PLENUM TO A RAPID COOLANT-EXPULSION PROCESS IN A LIQUID METAL FAST BREEDER REACTOR SINGLE-SUBASSEMBLY ACCIDENT. Chawla, T. C. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 48: No. 4, 397-402(Aug 1972).

Through the use of potential flow theory, an expression for two-dimensional axisymmetric pressure distribution in an "infinite" plenum for a coolant-expulsion process in a single-subassembly accident is obtained. An expression for the temporal distribution of the corresponding spatially averaged pressure at the exit of a fuel subassembly is also obtained. The illustrative example considered indicates that the use of a fixed-pressure boundary condition instead of a time-dependent-pressure boundary condition at the exit (or at the inlet) of a subassembly is not valid for very rapid transients, such as due to molten fuel-coolant interaction or to rapid release of fission gas from simultaneous or near-simultaneous breach of several pins near the top of the core region. Furthermore, the results of sample calculations presented for an FFTF subassembly indicate the possibility that, for a sufficiently rapid transient, the transient pressure in the exit region of the subassembly can fall to the saturation pressure of the sodium and result in local boiling during the expulsion in the exit region of the subassembly. The expression developed for the transient, spatially averaged pressure distribution in the plenum at the exit of a subassembly could be coupled with the one-dimensional type of analysis of the expulsion process in the fuel subassembly. 8 references. (auth)

4453 EARTHQUAKE-PROOF DESIGN. RESEARCH AND EXPLOITATION OF CIVIL ENGINEERING TECHNIQUES CONCERNED WITH ATOMIC POWER PLANTS. Okamoto, S. (Tokyo Univ.). Doboku Gakkaishi; 57: No. 2, 28-34(Feb 1972). (In Japanese).

The atomic subcommittee of Japan Civil Engineering Society has decided to study the following three important problems: construction of atomic power plants on not-very-firm ground; effects of faults on the construction of atomic power plants; and earthquake-proof design of intake and discharge systems of coolant water. The first problem is discussed, and results of a survey performed by static analysis are summarized. It was assumed that the Fukushima No. 1 plant is built on a sand bed. Three types of foundations, direct, caisson and pile, are assumed and analyzed for various conditions. Results of calculations are shown. (Japan)

Steam and Power Conversion System

Refer also to abstracts 2926 and 2928.

4454 (EURFNR–1010) RECUPERATIVE HEAT EXCHANGER FOR USE IN A FAST HELIUM-COOLED BREEDER REACTOR

WITH HELIUM TURBINE. Savatteri, C. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Feb 1972. 30p. (KFK-1566; EUR-4725). Dep. NTIS.

Work performed under United States–Euratom Fast Reactor Exchange Program.

In a plant operated by a gas-cooled fast breeder reactor and a gas turbine the amount of heat transferred in the regenerative heat exchanger is almost identical to that in the reactor. In case that the inlet temperatures of the turbine and the condenser are also fixed in advance, the efficiency of the process is decisively dependent on the heat exchanger. In order to obtain guiding lines for the final design of the regenerator of a 1000 MWe plant, a preliminary calculation of variations is carried out. This work investigates the influence of various parameters (tube diameter, pitch ratio, loss of pressure distribution) on the size of the heat exchanger. For better understanding of the problems the plant is briefly described. (8 references) (auth)

4455 NUCLEAR PLANTS USING BABCOCK PRESSURIZED-WATER REACTORS FOR THE STEAM PRODUCTION. Schlupp, K. F.; Schwabedissen, D. H. Energ. Nucl. (Paris); 14: No. 2, 127-33(1972). (In French).

The difference between plants using BBR reactors (Babcock–Brown Boveri Reactors) and the usual type of plants is that with BBR reactors superheated steam is produced instead of saturated steam. The higher steam temperature combined with the higher pressure leads to higher efficiency power plants. The installations for separating the moisture and drying the steam required by saturated steam systems are no longer necessary. Two steam generators are adequate to ensure the heat transmission in a 1200 MW(e) pressurized-water reactor. (France)

4456 DRAIN FLASH PHENOMENA IN NUCLEAR-POWER TURBINE. Furuya, Tetsuya; Isu, Yuichiro (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Toshiba Rebyu; 27: No. 5, 423-7(May 1972). (In Japanese).

Nuclear-power steam turbines should have initially slightly wet steam at their inlets because of various limitations characteristics of nuclear reactors. Accordingly they differ substantially in performance from conventional fossil-fuel turbines and are accompanied by various problems related to wetness of steam. The flashing of drains into steam and its effects on the turbine overspeed at load dump are discussed. (auth)

Commercial Power Reactors

4457 (BNL-17266) COSTS AND BENEFITS OF NUCLEAR POWER. Sailor, Vance L. (Brookhaven National Lab., Upton, N. Y.). 17 Oct 1972. 39p. Dep. NTIS.

The National Environmental Policy Act of 1969 (NEPA) requires that a cost-benefit analysis, considering all environmental effects, must be conducted for every proposed nuclear power facility and must include a cost-benefit analysis of appropriate alternatives. The background and effects of this legislation and the present status and safety record of operating nuclear power plants are reviewed. The factors to be considered in making a cost-benefit analysis and in evaluating the public safety hazards of nuclear power plants are presented. It is concluded that: the cost-benefit analysis required by NEPA is still in the primitive stages of development; in the case of nuclear plants, NEPA has begun to clarify some of the issues by requiring that information be assembled in a useful form; and, much remains to be done before the public understands and is reassured by the NEPA environmental reports. (L.C.L.)

4458 (DLCS-5000272) QUARTERLY OPERATING REPORT, Second Quarter 1972. (Duquesne Light Co., Shippingport Pa.). 1972. Contract AT(11-1)-292. 17p. Dep. NTIS.

All significant activities conducted at the Shippingport Atomic Power Station during April to July 1972 are reported. Information is included on: operations under normal conditions and during the June 1972 floods in the area; Core-2 Station performance; chemical testing to maintain specified chemical conditions in the reactor plant auxiliary systems; maintenance operations; and test programs associated with the plant operations. (L.C.L.)

4459 (FIND-50315(10-72)) FIND: DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Smith, J. G. (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 20 Oct 1972. 44p. Dep. NTIS.

An index to microfiche issuances of safety analysis reports is provided. Subject citations are to specific frames on the microfiche. (J.M.J.)

4460 PHILIPPSBURG NUCLEAR PLANT. Eilinghoff, K. J. Energ. Nucl. (Paris); 14: No. 2, 113-26(1972). (In French).

In each of the two 864MW(e) plants envisaged for the Philippsburg project, the steam is produced by Brunsbuettel AEG type boiling-water reactors. This arrangement will constitute the largest boiling-water type nuclear power plant system in Europe. The plants will be equipped with immersed axial pumps to ensure the circulation of the coolant fluid, and will possess a modern system, involving filtration, for evacuating the gases produced; a triple-phase transformer will be used for each 1060MVA block. The start-ups are scheduled for 1974 and 1977 respectively. (France)

4461 REACTOR DEVELOPMENT: WHAT DOES THE FUTURE HOLD? De Villiers, J. W. L. (Atomic Energy Board, Pelindaba, Pretoria). S. Afr. Mech. Eng.; 22: No. 1, 12-17 (Jan 1972).

The development of commercial nuclear reactor power stations is reviewed. Advanced reactor systems are discussed and their limitations pointed out. The concept of the Fluid Fueled Fast Reactor is proposed and its advantages over present reactor types discussed briefly. (INIS)

4462 FAST NEUTRON SPECTRA FROM THE ACTIVITY OF THRESHOLD DETECTORS IRRADIATED IN A WATER-MODERATED, WATER-COOLED REACTOR. Aglitskii, A. M.; Lomakin, S. S.; Morozov, A. G.; Petrov, V. I.; Popov, S. G. At. Energ. (USSR); 32: No. 6, 494-5(Jun 1972). (In Russian).

The integral spectra of fast neutrons in the experimental channels of the Novo–Voronezh Reactor had previously been determined with threshold detectors. Reduction of the differential spectra of fast neutrons was accomplished according to the values of the activation integrals previously obtained. Three methods were utilized, designated as the Dirks method, the iteration method, and a rapid determination. The principles of the three methods are outlined, and their results are shown to agree satisfactorily. (K.S.W.)

4463 ROAD TOWARD THE JOINT NUCLEAR POWER PLANT NECKAR (GKN). Loehle, H. (Gemeinschaftskernkraftwerk Neckar GmbH, Esslingen, Ger.). Atomwirt., Atomtech.; 17: No. 8, 408-9(Aug 1972). (In German).

In March 1971, the joint nuclear power plant association Neckar sent a letter of intent to the Kraftwerk Union AG for a complete nuclear power plant with a Siemans pressurized water reactor. Preliminary studies were concluded in December 1971 and, immediately after receipt of the first partial license, construction started on the 775 MW(e)-net nuclear power plant. The size of the installation was determined by participation of the German federal railroad which intends to use 150 MW(e). Environmental protection was a factor in the selection of a nuclear power plant. Described are preliminary planning, site, outline of the project, and public reaction. (H.B.G.)

4464 805 MW JOINT NUCLEAR POWER PLANT NECKAR WITH SIEMENS PRESSURE WATER REACTOR. Schubert, F. (Siemens AG, Erlangen, Ger.); Tschanneri, J. Atomwirt., Atomtech.; 17: No. 8, 410-14(Aug 1972). (In German).

The joint nuclear power plant Neckar will have a construction period of 51 months. After test operation, it will be released to the owners in early 1976. It follows the known series of nuclear power plants with Siemens pressurized water reactors and, with respect to size, it represents a further development of the nuclear power plant Stade. The GKN installation, however, has two special characteristics. On the total power of 805 MW(e) gross, the German railroad participates with 150 MW(e). This participation necessitates a two-turbine installation. The most significant technical change consists in a 3-loop installation which, for the first time, was realized in a German nuclear power plant because of technical advancements. Cooling towers are designed to handle the full power load. Described are site, construction of the total installation, and steam generation. Tabulated are the characteristics of the power plant. Floor plans are given for reactor building, machine housing, and support buildings. (H.B.G.)

Physics and Core Engineering

4465 ANALYSIS OF THE SPACE DEPENDENT NEUTRON FLUX DENSITY FLUCTUATIONS AT THE LINGEN BOILING WATER REACTOR (KWL) BY METHODS OF STOCHASTIC PROCESSES. Seifritz, W. (Technische Univ., Hanover). Atomkernenergie; 19: No. 4, 271-9(Jul 1972).

The reactor noise investigations described were performed at the Lingen nuclear power station (KWL) which is equipped with a boiling water reactor of 520 MW(t) design power. A movable

prompt response self-powered cobalt in-core detector in a dry thimble was used to monitor the mean neutron flux as well as the flux fluctuations in numerous axial reactor positions. Thus, a series of auto-correlation functions (and power spectra, respectively) were obtained which showed the influence of the boiling of the moderator on the statistical nature of the neutron flux fluctuations along the axial coordinate. It was observed that the shape of the auto power spectral density functions successively change from a low pass filter characteristic in the lower part of the reactor (non-boiling zone) to a band pass filter characteristic in the middle and upper parts of the reactor (bulk boiling zone) with the maximum at 0.4 cps and a bandwidth of 0.7 cps. In addition, the relative RMS noise intensity of the total flux fluctuations correspondingly increases from 0.68% to 0.83% resulting in a core averaged value of 0.78%. A qualitative interpretation of these space dependent effects is given. (32 references) (auth)

Containment Systems, Shielding, Waste Processing, and Radiation Protection

Refer also to abstract 3007.

4466 (DOCKET-50261-123) H. B. ROBINSON UNIT 2. Dilution of Boron Injection Tank; Containment Spray Pumps. (Carolina Power and Light Co., Raleigh, N. C.). 10 Nov 1972. 6p. Dep. NTIS.

4467 (DOCKET-50293-102) PILGRIM NUCLEAR POWER STATION. Unusual Occurrences UO-72-6 and UO-72-7. (Boston Edison Co., Mass.). 2 Nov 1972. 3p. Dep. NTIS.

The inoperability of the primary system boundary coolant leakage air sampling system and the plant stack monitoring system are reported. (H.D.R.)

4468 (DOCKET-50293-104) PILGRIM NUCLEAR POWER STATION. Unusual Occurrence UO-72-10. (Boston Edison Co., Mass.). 8 Nov 1972. 2p. Dep. NTIS.

The inoperability of a torus water temperature indicator is reported. (H.D.R.)

Cooling Systems

4469 (DOCKET-50280-89) SURRY POWER STATION, UNIT 1. Abnormal Occurrence Report of October 1, 1972, Supplemental Information. (Virginia Electric and Power Co., Richmond). 9 Nov 1972. 28p. Dep. NTIS.

Additional information on the failure of the bonnet gasket on a feedwater check valve is presented. (H.D.R.)

4470 (DOCKET-50340-5) SEABROOK NUCLEAR STATION, UNIT 1. Program Intended Relating to Wall Thickness of Nuclear Service Valves. (Public Service Co. of New Hampshire, Manchester). 10 Oct 1972. 4p. Dep. NTIS.

4471 INFLUENCE OF THERMAL STRESSES ON THE DESIGN OF THE FORT ST. VRAIN HTGR STEAM GENERATORS. Schuetzenduebel, W. G. (Gulf General Atomic, Inc., San Diego, Calif.). Energie; 24: No. 4, 90-9(1972). (In German).

A description of the steam generators, of design and properties, is followed by an explanation of the provisions for the control of thermal stresses. Moreover, the calculation methods and programs are given concerning the detailed stress analysis of all the parts of the steam generator. (GF)

4472 RECIRCULATION COOLING IN CONVENTIONAL AND NUCLEAR POWER PLANTS. Krolewski, H. (Vereinigte Elektrizitaetswerke Westfalen AG, Dortund, Ger.); Blanck, D.; Hoeft, K. Atomwirt., Atomtech.; 17: No. 8, 420-8(Aug 1972). (In German).

In West Germany, approximately half of the electric power is generated in plants with recirculation cooling. In the interior of the country, no large power plant without recirculation cooling is granted a license, which implies a considerable increase in investment costs. In the current decade, wet-cooling will be available to a predominant degree. Within the foreseeable future, however, the cooling water problem will require installation of dry-cooling systems. Even then, a nuclear power plant cannot dispense with nearness to surface waters. Discussed are the present states of wet and dry recirculation cooling, questions about optimization, and economics. 17 references. (H.B.G.)

4473 QUANTITATIVE ASSESSMENT OF RELIABILITY OF BELOYARSK ATOMIC POWER STATION PUMPS BASED ON OPERATIONAL DATA. Emel'yanov, I. Ya.; Shasharin, G. A.; Kireev, G. A.; (and others). At. Energ. (USSR); 33: No. 1, 547-51(Jul 1972). (In Russian).

A quantitative assessment of the reliability of the main circulating pumps, feed pumps, control and safety cooling pumps at the Beloyarsk Atomic Power Station has been carried out on the basis of statistical operational data for the period from 1965 to 1970 for the first reactor block and from 1968 to 1970 for the second. There has been applied a new approach to the assessment of the reliability of equipment which involves the consideration of three flows of events: flow of failures, flow of malfunctions and summation flow (failures and malfunctions). The exponential nature of operation time distributions between pump failures has been confirmed. For the first time in Soviet practice, quantitative reliability indicators of the pumps under consideration have been found and the main causes of failures and malfunctions determined. The results obtained can be used to predict the reliability of functioning nuclear plants as well as those under development: to calculate the optimal frequency of preventive maintenance of pumps; to improve pump design; and to estimate stock requirements for spare parts etc. (auth)

Fuel Systems and Components

4474 (WCAP-7984) FUEL DENSIFICATION PENALTY MODEL. Eng, G.; Hopkins, G. W.; Rim, C. S.; George, R. A.; Boman, L. H.; Burnett, T. W. T. (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Energy Systems Div.). Oct 1972. 104p. Dep. NTIS.

A model for fuel densification and its effect on the operation of power plants using fuel which can densify is described. Fuel densification causes pellets to shrink both axially and radially. The pellet axial shrinkage combined with random pellet hangup caused by fuel-clad interaction results in gaps in the fuel column at irregular intervals. Densification can cause local power increases, reduction of fuel column length and an increase in fuel pellet temperature. (J.M.J.)

Auxiliary Systems, Protection Systems, and Engineered Safeguards

4475 (DOCKET-50295-68) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Design Changes to Residual Heat Removal Heat Exchangers. (Commonwealth Edison Co., Chicago, Ill.). 25 Oct 1972. 3p. (DOCKET-50304-68). Dep. NTIS.

4476 DEVELOPMENT OF FUELLING GRABHEADS AND THEIR INSTRUMENTATION FOR GAS-COOLED NUCLEAR REACTORS. Davies, D. T. L. (General Electric Co., Whetstone, Eng.). J. Sci. Technol. (London); 39: No. 2, 46-51 (1972).

The function of the grabhead in a nuclear power station is the charge and discharge of fuel elements in the reactor core and the loading and unloading of the fuelling machine. The design and major problems encountered in the original pneumatically-actuated grabhead for Hinkley Point and Sizewell are discussed. The development of the solenoid is outlined and details are given of the design of solenoid-actuated grabheads used at Trawsfynydd and Wylfa, and of the instrumentation for positioning. Advantages are a reduction in complexity, reliability and lower cost. (UK)

Operation and Economics

4477 (CONF-721109-10) NUCLEAR FUEL LOGISTICS. Golan, S.; Salmon, R. (Oak Ridge National Lab., Tenn.). 3 Oct 1972. 32p. Dep. NTIS.

From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

An overview of the nuclear fuel cycle logistical requirements under conditions anticipated in the U. S. over the next 30 years is provided. The requirements in the pre-1990 period will be dominated by LWR's and involve little uncertainty from a new facility planning viewpoint. The requirements in the post-1990 period involve major uncertainties as they are strongly dependent on the sharing of the market between LWR, HTGR, and FBR systems. Large-scale FBR introduction by the mid 1980's would significantly reduce the required capital investment for uranium supply and enrichment facilities and would provide investment protection to thermal reactor operators by slowing down the drain on our low cost uranium reserves. New capital investment in the nuclear fuel cycle industry would average around 1.5 billion (1972) dollars per year over the next 20 years of which about 90 percent would be needed for the supply of U_3O_8 and separative work and 10 percent for fuel fabrication and reprocessing. 17 references. (auth)

4478 (DOCKET-1151–60) ELK RIVER REACTOR. Status Report on Deactivated Reactor, August 1, 1972–November 1, 1972. (United Power Association, Elk River, Minn. (USA)). 14 Nov 1972. 25p. Dep. NTIS.

4479 (DOCKET-50003–138) INDIAN POINT STATION, UNIT 1. Inspection of September 28, 1972. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 18 Oct 1972. 11p. Dep. NTIS.

4480 (DOCKET-50003–139) INDIAN POINT STATION, UNIT 1. Technical Specifications, Proposed Changes. (Consolidated Edison Co. of New York, Inc., New York). 16 Nov 1972. 33p. Dep. NTIS.

Changes are proposed to the reactor for the Core B, Cycle 5 reload design and operating characteristics. Six changes are requested for the technical specifications in association with the refueling. (H.D.R.)

4481 (DOCKET-50003–140) INDIAN POINT STATION, UNIT 1. Semiannual Periodic Test on November 7, 1972. (Consolidated Edison Co. of New York, Inc., New York). 17 Nov 1972. 2p. Dep. NTIS.

4482 (DOCKET-50016–149) ENRICO FERMI ATOMIC POWER PLANT. Technical Specification, Change No. 32 Allowed. (Division of Reactor Licensing (AEC), Washington, D. C.). 23 Feb 1972. 1p. Dep. NTIS.

Revised technical specifications are presented concerning the testing schedule for the liquid sodium siphon lines. (D.C.C.)

4483 (DOCKET-50016–174) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Report for August 1972. (Power Reactor Development Co., Detroit, Mich.). 15 Nov 1972. 13p. (PRDC-EF–108). Dep. NTIS.

4484 (DOCKET-50029–211) YANKEE NUCLEAR POWER STATION. Abnormal Occurrence 72-19. (Yankee Atomic Electric Co., Rowe, Mass.). 2 Nov 1972. 1p. Dep. NTIS.

Information is presented concerning the failure of a solenoid operated valve during a surveillance test of the trip system for the vapor container isolation valves. (D.C.C.)

4485 (DOCKET-50219–221) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Isolation Condenser System Failures. (Jersey Central Power and Light Co., Morristown, N. J.). 22 Nov 1972. 4p. Dep. NTIS.

4486 (DOCKET-50220–112) NINE MILE POINT NUCLEAR STATION, UNIT 1. Failure of Main Fuel Grapple. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 3 Nov 1972. 3p. Dep. NTIS.

4487 (DOCKET-50220–113) NINE MILE POINT NUCLEAR STATION, UNIT 1. Leakage into Drywell Equipment Drain Tanks. (Niagara Mohawk Power Corp., Lycoming, N. Y.). 3 Nov 1972. 2p. Dep. NTIS.

4488 (DOCKET-50220–114) NINE MILE POINT NUCLEAR STATION, UNIT 1. Leak Testing of Valves, Supplements Letter of August 1, 1972. (Niagara Mohawk Power Corp., Lycoming, N. Y.). 15 Nov 1972. 2p. Dep. NTIS.

4489 (DOCKET-50237–274) DRESDEN NUCLEAR POWER STATION, UNIT 2. No. 3 Turbine Control Valve Fast-Acting Solenoid Would Not Actuate. (Commonwealth Edison Co., Chicago, Ill.). 6 Nov 1972. 4p. Dep. NTIS.

4490 (DOCKET-50237–275) DRESDEN NUCLEAR POWER STATION, UNIT 2. HPCI Steam Valve 2-2301-4 in Dry Well Would Not Open. (Commonwealth Edison Co., Morris, Ill. (USA)). 6 Nov 1972. 2p. Dep. NTIS.

4491 (DOCKET-50237–279) DRESDEN NUCLEAR POWER STATION, UNIT 2. High Pressure Coolant Injection Valve Would Not Open on Test. (Commonwealth Edison Co., Chicago, Ill.). 15 Nov 1972. 2p. Dep. NTIS.

4492 (DOCKET-50237–280) DRESDEN NUCLEAR POWER STATION, UNIT 2. All Main Steam Line Low Pressure Switches Below Limit of 850 PSIG. (Commonwealth Edison Co., Morris, Ill. (USA)). 21 Nov 1972. 1p. Dep. NTIS.

4493 (DOCKET-50244–124) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Discovery of a Fuel Rod End Plug in the Reactor. (Rochester Gas and Electric Corp., N. Y.). 30 Oct 1972. 5p. Dep. NTIS.

4494 (DOCKET-50244–125) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. November 1972 Startup Physics Testing. (Rochester Gas and Electric Corp., N. Y.). 3 Nov 1972. 2p. Dep. NTIS.

4495 (DOCKET-50244–130) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Monthly Report of Activity Measurements, September 26, 1972–October 25, 1972. (Rochester Gas and Electric Corp., N. Y.). 15 Nov 1972. 2p. Dep. NTIS.

4496 (DOCKET-50247–85) INDIAN POINT NUCLEAR GENERATING UNIT 2. Investigation and Consequences of a Steam Generator Nozzle Debris Plug Assembly Being Inadvertently Left in Place During Operation of the Reactor Coolant System. (Consolidated Edison Co. of New York, Inc., New York). 25 Oct 1972. 6p. Dep. NTIS.

4497 (DOCKET-50247–86) INDIAN POINT NUCLEAR GENERATING UNIT 2. Investigation of Welds and Pipe Wall Thickness in Vent and Drain Assemblies. (Consolidated Edison Co. of New York, Inc., New York). 26 Sep 1972. 7p. Dep. NTIS.

4498 (DOCKET-50247–87) INDIAN POINT NUCLEAR GENERATING UNIT 2. Retrieval of Bolt-and-Wing Nut Reported Missing, October 11, 1972. (Consolidated Edison Co. of New York, Inc., New York). 30 Oct 1972. 2p. Dep. NTIS.

4499 (DOCKET-50249–169) DRESDEN NUCLEAR POWER STATION, UNIT 3. No. 1 Off-Gas Monitor Trip Point Found Out of Calibration. (Commonwealth Edison Co., Chicago, Ill.). 27 Oct 1972. 2p. Dep. NTIS.

4500 (DOCKET-50249–171) DRESDEN NUCLEAR POWER STATION, UNIT 3. Low Pressure Switches Out of Calibration. (Commonwealth Edison Co., Morris, Ill. (USA)). 20 Nov 1972. 1p. Dep. NTIS.

4501 (DOCKET-50250–103) TURKEY POINT PLANT, UNITS 3 AND 4. Abnormal Occurrence No. 3-72-7, Partial Flooding of Switchgear Rooms. (Florida Power and Light Co.). 17 Nov 1972. 2p. (DOCKET-50251–83). Dep. NTIS.

4502 (DOCKET-50254–136) QUAD-CITIES STATION, UNITS 1 AND 2. Temperature Monitoring for Side Jet Operation. (Commonwealth Edison Co., Chicago, Ill.). 23 Oct 1972. 235p. (DOCKET-50265–127). Dep. NTIS.

4503 (DOCKET-50254–143) QUAD-CITIES STATION, UNIT 1. Incident Involving Outboard Main Steam Isolation Valve, Additional Details. (Commonwealth Edison Co., Cordova, Ill.). 24 Nov 1972. 2p. Dep. NTIS.

4504 (DOCKET-50254–144) QUAD-CITIES STATION, UNITS 1 AND 2. Vacuum Breaker Interim Surveillance. (Commonwealth Edison Co., Chicago, Ill.). 17 Nov 1972. 2p. (DOCKET-50265–135). Dep. NTIS.

4505 (DOCKET-50255–111) PALISADES PLANT. Diesel Generator Breaker Failed to Open. (Consumers Power Co., Jackson, Mich.). 10 Nov 1972. 2p. Dep. NTIS.

4506 (DOCKET-50255–112) PALISADES PLANT. Further Information on Predicted Fuel Collapse. (Consumers Power Co., Jackson, Mich.). 13 Nov 1972. 2p. Dep. NTIS.

4507 (DOCKET-50255–115) PALISADES PLANT. Control Rod Drive Mechanism Testing Program. (Consumers Power Co., Jackson, Mich.). 20 Nov 1972. 2p. Dep. NTIS.

4508 (DOCKET-50261–120) H. B. ROBINSON UNIT 2. Monthly Report of Primary and Secondary Activity Measuements and Effluent Discharge Activity Levels. (Carolina Power and Light Co., Raleigh, N. C.). 30 Oct 1972. 2p. Dep. NTIS.

4509 (DOCKET-50261–121) H. B. ROBINSON UNIT 2. Personnel Hatch Jammed. (Carolina Power and Light Co., Raleigh, N. C.). 31 Oct 1972. 1p. Dep. NTIS.

4510 (DOCKET-50261–122) H. B. ROBINSON UNIT 2. Service Water Booster Pumps. (Carolina Power and Light Co., Raleigh, N. C.). 30 Oct 1972. 1p. Dep. NTIS.

4511 (DOCKET-50261–126) H. B. ROBINSON UNIT 2. Containment Vessel Integrity. (Carolina Power and Light Co., Raleigh, N. C.). 20 Nov 1972. 1p. Dep. NTIS.

4512 (DOCKET-50263–158) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Standby Liquid Control Relief

Valve Malfunction. (Northern States Power Co., Minneapolis, Minn.). 3 Nov 1972. 1p. Dep. NTIS.

4513 (DOCKET-50263–159) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Standby Liquid Control System Surveillance Test Inadequacy. (Northern States Power Co., Minneapolis, Minn.). 9 Nov 1972. 1p. Dep. NTIS.

4514 (DOCKET-50263–160) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Inoperability of Primary Containment Valve Boot Seals; Failure of Reactor Building to Torus Vacuum Breaker Differential Pressure Control Switch. (Northern States Power Co., Minneapolis, Minn.). 16 Nov 1972. 2p. Dep. NTIS.

4515 (DOCKET-50265–129) QUAD-CITIES STATION, UNIT 2. Incident Involving the HPCI System. (Commonwealth Edison Co., Cordova, Ill.). 3 Nov 1972. 2p. Dep. NTIS.

Malfunction of the high pressure coolant injection turbine stop valve is described. Corrective actions are discussed. (D.C.C.)

4516 (DOCKET-50266–89) POINT BEACH NUCLEAR PLANT, UNIT 1. Fuel Examination, Additional Information. (Wisconsin Electric Power Co., Milwaukee). 10 Nov 1972. 11p. Dep. NTIS.

4517 (DOCKET-50266–90) POINT BEACH NUCLEAR PLANT, UNIT 1. Exposure of an Individual to Radiation on October 6, 1972. (Wisconsin Electric Power Co., Milwaukee). 24 Nov 1972. 6p. Dep. NTIS.

4518 (DOCKET-50267–48) FORT ST. VRAIN NUCLEAR GENERATING STATION. Deficiency Report Standby Diesel-Generators. (Public Service Co. of Colorado, Denver). 9 Oct 1972. 4p. Dep. NTIS.

4519 (DOCKET-50267–49) FORT ST. VRAIN NUCLEAR GENERATING STATION. Standby Diesel Generators Valves Stuck. (Public Service Co. of Colorado, Denver). 20 Oct 1972. 4p. Dep. NTIS.

4520 (DOCKET-50271–114) VERMONT YANKEE NUCLEAR POWER STATION. Operations Report 72-8. (Vermont Yankee Nuclear Power Corp., Rutland). 17 Oct 1972. 28p. Dep. NTIS.

4521 (DOCKET-50271–117) VERMONT YANKEE NUCLEAR POWER STATION. Abnormal Occurrence No. AO-72-10. (Vermont Yankee Nuclear Power Corp., Rutland). 8 Nov 1972. 1p. Dep. NTIS.

Information is presented concerning the failure of the scram discharge volume high water level switch to actuate at the specified setpoint. Corrective actions are described. (D.C.C.)

4522 (DOCKET-50271–118) VERMONT YANKEE NUCLEAR POWER STATION. Piston Rings in Valve Operator of Valve 109-76B Removed. (Vermont Yankee Nuclear Power Corp., Rutland). 7 Nov 1972. 2p. Dep. NTIS.

4523 (DOCKET-50280–90) SURRY POWER STATION, UNITS 1 AND 2. Operating Incident of July 27, 1972. (Virginia Electric and Power Co., Richmond). 16 Nov 1972. 2p. (DOCKET-50281–78). Dep. NTIS.

Additional information is presented concerning the excessive high temperatures in the engineered safeguards building. (D.C.C.)

4524 (DOCKET-50285–77) FORT CALHOUN STATION, UNIT 1. Environmental Radioactivity Surveillance Program, Pre-Operational Report, Second Quarter, 1972. (Eberline Instrument Corp., Santa Fe, N. Mex. Dept. of Nuclear Sciences). 13 Nov 1972. 26p. Dep. NTIS.

For Omaha Public Power District, Nebr.

4525 (DOCKET-50289–76) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Circulating Water Expansion Joint Failure. (Metropolitan Edison Co., Reading, Pa.). 10 Nov 1972. 4p. (DOCKET-50320–35). Dep. NTIS.

4526 (DOCKET-50293–105) PILGRIM NUCLEAR POWER STATION. Abnormal Occurrence AO-72-14. (Boston Edison Co., Mass.). 18 Nov 1972. 2p. Dep. NTIS.

Additional information is presented concerning the incorrect calibration of the reactor low pressure switches for the reactor protection system. (D.C.C.)

4527 (DOCKET-50295–67) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Corrosion of Tendons and Malfunction of Torque Switches. (Commonwealth Edison Co., Chicago, Ill.). 20 Oct 1972. 4p. (DOCKET-50304–67). Dep. NTIS.

4528 (DOCKET-50305–57) KEWAUNEE NUCLEAR POWER PLANT. Plans for Loss of Instrument Air Testing. (Wisconsin Public Service Corp., Green Bay). 16 Oct 1972. 3p. Dep. NTIS.

4529 (DOCKET-50309–75) MAINE YANKEE ATOMIC POWER STATION. Oversized Capscrew Interferred With Withdrawal of Control Element Assembly 59. (Maine Yankee Atomic Power Co., Westboro, Mass.). 26 Oct 1972. 2p. Dep. NTIS.

4530 (DOCKET-50309–77) MAINE YANKEE ATOMIC POWER STATION. Coolant Pump Guide Vane Failure. (Maine Yankee Atomic Power Co., Westboro, Mass.). 11 Sep 1972. 6p. Dep. NTIS.

4531 (DOCKET-50309–78) MAINE YANKEE ATOMIC POWER STATION. Inspection and Repair of Valves. (Maine Yankee Atomic Power Co., Westboro, Mass.). 25 Oct 1972. 11p. Dep. NTIS.

4532 (DOCKET-50309–79) MAINE YANKEE ATOMIC POWER STATION. Monthly Report 9-72, September 1972. (Maine Yankee Atomic Power Co., Westboro, Mass.). 7 Nov 1972. 12p. Dep. NTIS.

4533 (DOCKET-50309–80) MAINE YANKEE ATOMIC POWER STATION. Dropped Control Rod During Test. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 27 Oct 1972. 2p. Dep. NTIS.

4534 (DOCKET-50309–81) MAINE YANKEE ATOMIC POWER STATION. Faulty Coil Power Programmer Caused Dropped Control Element Assembly. (Maine Yankee Atomic Power Co., Westboro, Mass.). 13 Nov 1972. 2p. Dep. NTIS.

4535 (DOCKET-50311–46) SALEM NUCLEAR GENERATING STATION, UNIT 2. Reactor Lower Internals Failure of Moving Equipment. (Public Service Electric and Gas Co., Newark, N. J.). 20 Oct 1972. 5p. Dep. NTIS.

4536 (DOCKET-50315–88) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 33. (Indiana and Michigan Power Co., New York). 2 Nov 1972. 4p. (DOCKET-50316–88). Dep. NTIS.

4537 (DOCKET-50317–66) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Failure of a 125V Battery Charger. (Baltimore Gas and Electric Co., Md.). 20 Sep 1972. 3p. (DOCKET-50318–63). Dep. NTIS.

4538 (DOCKET-50317–70) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Distortion of the 34-Inch Main Steam Line. (Baltimore Gas and Electric Co., Md.). 14 Nov 1972. 3p. (DOCKET-50318–67). Dep. NTIS.

4539 (DOCKET-50331–61) DUANE ARNOLD ENERGY CENTER. Replacement of Reactor Core Support Bolts. (Iowa Electric Light and Power Co., Cedar Rapids). 11 Oct 1972. 3p. Dep. NTIS.

4540 (DOCKET-50336–47) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 2. Replacement of Damaged Nozzle in the Closure Head of the Reactor Pressure Vessel. (Millstone Point Co., Hartford, Conn.). 11 Oct 1972. 10p. Dep. NTIS.

4541 (DOCKET-50344–33) TROJAN NUCLEAR PLANT. Reactor Vessel Repair. (Portland General Electric Co., Oreg.). 19 Oct 1972. 2p. Dep. NTIS.

4542 (DOCKET-50409–21) LA CROSSE BOILING WATER REACTOR. Containment Leakage Rate Test Requirements. (Dairyland Power Cooperative, La Crosse, Wis.). 27 Oct 1972. 5p. Dep. NTIS.

4543 (DOCKET-50410–12) NINE MILE POINT NUCLEAR STATION, UNIT 2. Preliminary Safety Analysis Report, Supplement 2. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 14 Nov 1972. 25p. Dep. NTIS.

Requested data on the staff and conduct of operations are presented. (H.D.R.)

4544 (ORP/SID–72-4, pp 116-30) WHAT THE FUTURE HOLDS FOR NUCLEAR POWER. Tremmel, E. B. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

The history of AEC activities and budgets is briefly reviewed, and projections are made of future AEC and private industry involvements in supplying nuclear power to meet energy needs to the year 2000. Information is included on electric power costs, U.S.

energy consumption, energy reserves, uranium requirements, population growth, significance of the LMFBR, and existing and planned nuclear power plants. (L.C.L.)

4545 (TID–26007) COST COMPARISON OF DRY-TYPE AND CONVENTIONAL COOLING SYSTEMS FOR REPRESENTATIVE NUCLEAR GENERATING PLANTS. Rossie, J. P.; Cecil, E. A.; Young, R. O. (Beck (R. W.) and Associates, Denver, Colo. (USA)). Mar 1972. Contract AT(04-3)-848. 134p. Dep. GPO $1.25.

Results are presented of studies made to determine the estimated effect on the cost of electric power from three nuclear generating plants now under construction if dry-type cooling systems were used instead of the conventional evaporative cooling systems which are actually being built. The three nuclear plants selected for study are in the northeastern, southeastern, and western US. The physical and operating characteristics of dry-type and conventional cooling systems for condenser water, as well as the relative economics of the different cooling methods, are compared. It was concluded that dry-cooling would increase the energy production costs by about 0.9 mill/kWh for the three plants studied, which would mean approximately a 4.5% increase in the average retail cost. However, dry cooling has several advantages such as no thermal effects on surface waters, greater flexibility in plant siting, which would reduce transmission costs, and which would permit construction of additional generating units on sites without sufficient additional cooling water, and would possibly have lower maintenance costs than plants with evaporative cooling towers. (L.C.L.)

4546 (TID–26210) GARIGLIANO NUCLEAR POWER STATION. Operation Report for the 1st Quarter of 1972. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). 31 Mar 1972. 19p. Dep. NTIS.

4547 FIRE DAMAGE AT MUEHLEBERG NUCLEAR POWER STATION. Lutz, H. R. (Bernische Kraftwerke AG, Muehleberg, Switzerland); Schreiber, A.; Weehuizen, F. H. J.; Diener, W. VGB Kraftwerkstechnik; 52: No. 3, 183-96(1972). (In German).

On July 28, 1971 an oil fire, which developed into a cable fire, broke out at the Muehleberg Nuclear Power Station (306 MW) of the Berne Power Plant Company. The cause of the fire was the leakage and ignition of turbine oil from a loose pipe connection. The material damage amounts to about 20×10^6 Francs; plant repairs took almost a year. (GF)

4548 DEVELOPMENT OF THE PLUTONIUM PRICE IN OPTIMAL COST POWER GENERATING SYSTEMS. Einhaus, R. (STEAG, Essen); Harders, H. Atomkernenergie; 20: No. 2, 127-34(Oct 1972). (In German).

For the development of the plutonium price the internal value of plutonium within optimal cost power generating systems is important. This internal value is computed simultaneously with the determination of the optimal cost power generating system. But on account of the finiteness of the optimization period the time dependence of the plutonium value is normally not realistic at the end of this period. This can be avoided by an appropriate valuation of the plutonium, which is bound in the system at the end of the optimization period. By this means a relatively short optimization period can be chosen. This facilitates the consideration of not too simplified system models. (auth)

Safety and Siting

Refer also to abstracts 2521, 2528, 2536, 2537, 2540, and 2837.

4549 (BAW–10048(Suppl.1)(Rev.2)) MULTINODE ANALYSIS OF B AND W'S 145-FUEL-ASSEMBLY NUCLEAR PLANTS DURING LOSS-OF-COOLANT ACCIDENT. Parks, C. E.; Allen, R. J.; Schermer, W. J. (Babcock and Wilcox Co., Lynchburg, Va. Power Generation Div.). Oct 1972. 5p.

An analysis of the double-ended break of the pipe that connects a core flood tank to the reactor vessel at a point between the reactor vessel core flooding line nozzle and the first upstream check valve in the flooding line is discussed. The analysis utilizes the evaluation model described in BAW-10048, Multinode Analysis of B&W's 145-Fuel Assembly Nuclear Plants During Loss-of-Coolant Accident. (auth)

4550 (DOCKET-50003–137) INDIAN POINT STATION, UNIT 1. Installation of a Thermowell in Decay Heat Return Line Neither Warranted or Necessary. (Consolidated Edison Co. of New York, Inc., New York). 3 Nov 1972. 2p. Dep. NTIS.

4551 (DOCKET-50003–141) INDIAN POINT STATION, UNIT 1. Technical Specifications, Proposed Section 6.0. (Consolidated Edison Co. of New York, Inc., New York). 24 Nov 1972. 9p. Dep. NTIS.

Revised technical specifications are presented concerning reporting requirements for reactor operations. (D.C.C.)

4552 (DOCKET-50010–122) DRESDEN NUCLEAR POWER STATION, UNIT 1. Proposed Change 17, Supplement H. (Commonwealth Edison Co., Chicago, Ill.). 8 Nov 1972. 2p. Dep. NTIS.

Revised information is presented concerning the emergency core cooling system. (D.C.C.)

4553 (DOCKET-50029–212) YANKEE NUCLEAR POWER STATION. Revised Loss of Coolant Analysis for an Isolated Loop. (Yankee Atomic Electric Co., Westboro, Mass.). 30 Oct 1972. 43p. Dep. NTIS.

4554 (DOCKET-50133–99) HUMBOLDT BAY POWER PLANT, UNIT 3. Valve Wall Thickness. (Directorate of Regulatory Operations (AEC), Berkeley, Calif. (USA). Region V). 16 Nov 1972. 5p. Dep. NTIS.

4555 (DOCKET-50155–130) BIG ROCK POINT NUCLEAR PLANT. Technical Specifications, Change 31, Additional Information No. 2. (Consumers Power Co., Jackson, Mich.). 15 Nov 1972. 5p. Dep. NTIS.

Requested information is presented concerning the quality assurance program and quality control checks for fuel element manufacture. (D.C.C.)

4556 (DOCKET-50206–175) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Minimum Wall Thickness of Safety Related Valves. (Southern California Edison Co., Rosemead, Calif.). 17 Jul 1972. 7p. Dep. NTIS.

4557 (DOCKET-50219–220) OYSTER CREEK NUCLEAR POWER PLANT, UNIT 1. Environmental Report, Amendment 2. (Jersey Central Power and Light Co., Morristown, N. J.). 17 Nov 1972. 136p. Dep. NTIS.

4558 (DOCKET-50220–115) NINE MILE POINT NUCLEAR STATION, UNIT 1. Technical Specifications, Proposed Revisions to Administrative Controls Section. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 22 Nov 1972. 13p. Dep. NTIS.

4559 (DOCKET-50237–276) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. QUAD-CITIES STATION, UNITS 1 AND 2. Special Report No. 4A, Supplementary Information (Dresden Nuclear Power Station, Units 2 and 3); Special Report No. 1 (Quad-Cities Station, Units 1 and 2): Modified Off-Gas System. (Commonwealth Edison Co., Chicago, Ill.). 8 Nov 1972. 16p. (DOCKET-50249–168; DOCKET-50254–138; DOCKET-50265–130). Dep. NTIS.

4560 (DOCKET-50237–277) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Special Report No. 18, Dresden 2/3 Safety Valve Investigations. (Commonwealth Edison Co., Chicago, Ill.). 13 Nov 1972. 26p. (DOCKET-50249–170). Dep. NTIS.

4561 (DOCKET-50237–278) DRESDEN NUCLEAR POWER STATION, UNIT 2. Application for Conversion of Provisional Operating License DPR-19 to a Full Term License. (Commonwealth Edison Co., Chicago, Ill.). 15 Nov 1972. 1p. Dep. NTIS.

4562 (DOCKET-50237–281) DRESDEN NUCLEAR POWER STATION, UNITS 2 AND 3. Delay in Submittal of Torus Baffle Studies. (Commonwealth Edison Co., Chicago, Ill.). 27 Nov 1972. 3p. (DOCKET-50249–172). Dep. NTIS.

4563 (DOCKET-50244–126) ROBERT EMMETT GINNA NUCLEAR POWER PLANT, UNIT 1. Potential Exposure of Workman to Higher Than Permissible Concentrations. (Rochester Gas and Electric Corp., N. Y.). 31 May 1972. 7p. Dep. NTIS.

4564 (DOCKET-50245–171) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Wall Thickness of Nuclear Service Valves. (Millstone Point Co., Hartford, Conn.). 10 Oct 1972. 6p. Dep. NTIS.

4565 (DOCKET-50245–172) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 1. Abnormal Occurrences AO-72-26 and AO-72-27. (Millstone Point Co., Hartford, Conn.). 21 Oct 1972. 2p. Dep. NTIS.

The detection of cracks in the feedwater spargers and the discovery that the containment penetrations and isolation valves will not meet leak rate specifications are reported. (H.D.R.)

4566 (DOCKET-50250–101) TURKEY POINT PLANT, UNITS 3 AND 4. Design Changes in Residual Heat Removal System Valves. (Florida Power and Light Co.). 2 Oct 1972. 3p. (DOCKET-50251–81). Dep. NTIS.

4567 (DOCKET-50250-102) TURKEY POINT PLANT, UNITS 3 AND 4. Determination If Failure of Non-Category I (Seismic) Equipment Could Adversely Affect Safety-Related Equipment. (Florida Power and Light Co.). 6 Nov 1972. 3p. (DOCKET-50251-82). Dep. NTIS.

4568 (DOCKET-50250-104) TURKEY POINT PLANT, UNITS 3 AND 4. Final Safety Analysis Report, Revision 30. (Florida Power and Light Co.). 21 Nov 1972. 25p. (DOCKET-50251-84). Dep. NTIS.

Additional information is presented concerning radioactive waste disposal systems, power conversion system, cooling system, auxiliary systems, and layout of structures and equipment. (D.C.C.)

4569 (DOCKET-50254-137) QUAD-CITIES STATION, UNITS 1 AND 2. Operating Licenses, Proposed Changes. (Commonwealth Edison Co., Chicago, Ill.). 6 Nov 1972. 109p. (DOCKET-50265-128). Dep. NTIS.

Changes are proposed in the facility operating license to include authorized possession of all byproduct materials and to make corrections and additions to the Technical Specifications. (H.D.R.)

4570 (DOCKET-50254-139) QUAD-CITIES STATION, UNITS 1 AND 2. Special Report No. 3A, Condensate Pump Room Modifications. (Commonwealth Edison Co., Chicago, Ill.). 7 Nov 1972. 62p. (DOCKET-50265-131). Dep. NTIS.

4571 (DOCKET-50254-140) QUAD-CITIES STATION, UNITS 1 AND 2. Technical Specifications, Additional Proposed Changes. (Commonwealth Edison Co., Chicago, Ill.). 16 Nov 1972. 16p. (DOCKET-50265-132). Dep. NTIS.

Revised technical specifications are presented concerning the drywell to torus vacuum breakers, and the condensate pump room flood protection systems. (D.C.C.)

4572 (DOCKET-50254-142) QUAD-CITIES STATION, UNITS 1 AND 2. Technical Specifications, Proposed Modification 72-1. (Commonwealth Edison Co., Chicago, Ill.). 16 Nov 1972. 9p. (DOCKET-50265-134). Dep. NTIS.

Revised data are presented concerning fuel element performance, main steam line isolation valve leak rate, failure of the rod block monitor, and operations in the startup and hot standby mode. (D.C.C.)

4573 (DOCKET-50259-69) BROWNS FERRY NUCLEAR POWER STATION, UNITS 1, 2, AND 3. Final Safety Analysis Report, Amendment 44. (Tennessee Valley Authority, Chattanooga). 10 Nov 1972. 34p. (DOCKET-50260-65; DOCKET-50296-62). Dep. NTIS.

Revised and requested data are presented concerning personnel, inspection program, containment structure, transients without scram, and the rod sequence control system. (D.C.C.)

4574 (DOCKET-50261-119) H. B. ROBINSON UNIT 2. Integrity of Steam Generators Under Accident Conditions. (Carolina Power and Light Co., Raleigh, N. C.). 27 Oct 1972. 20p. Dep. NTIS.

4575 (DOCKET-50261-124) H. B. ROBINSON UNIT 2. Relationships Between Nuclear Hot Channel Factors and Control and Part Length Control Rod Configurations. (Carolina Power and Light Co., Raleigh, N. C.). 10 Nov 1972. 16p. Dep. NTIS.

4576 (DOCKET-50263-157) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Mississippi River Flow and Temperature Data. (Northern States Power Co., Minneapolis, Minn.). 7 Nov 1972. 15p. Dep. NTIS.

4577 (DOCKET-50263-161) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Final Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Nov 1972. 294p. Dep. NTIS.

The environmental effects of construction and operation of the Monticello Power Reactor Unit 1 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

4578 (DOCKET-50269-79) OCONEE NUCLEAR STATION, UNIT 1. Proposed Technical Specification 4.16, Non-Radiological Environmental Surveillance. (Duke Power Co., Charlotte, N. C.). 7 Aug 1972. 7p. Dep. NTIS.

4579 (DOCKET-50270-67) OCONEE NUCLEAR STATION, UNITS 2 AND 3. Auxiliary Service Water System. (Duke Power Co., Charlotte, N. C.). 20 Nov 1972. 3p. (DOCKET-50287-59). Dep. NTIS.

4580 (DOCKET-50272-45) SALEM NUCLEAR GENERATING STATION, UNITS 1 AND 2. Failure of Non-Class I (Seismic) Equipment. (Public Service Electric and Gas Co., Newark, N. J.). 2 Nov 1972. 2p. (DOCKET-50311-45). Dep. NTIS.

4581 (DOCKET-50275-27) DIABLO CANYON NUCLEAR POWER PLANT, UNITS 1 AND 2. Minimum Wall Thickness of Safety Related Valves. (Pacific Gas and Electric Co., San Francisco, Calif.). 20 Jul 1972. 7p. (DOCKET-50323-24). Dep. NTIS.

4582 (DOCKET-50277-66) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Amendment 22. (Philadelphia Electric Co., Pa.). 31 Oct 1972. 87p. (DOCKET-50278-66). Dep. NTIS.

Revised and additional data are presented concerning safety analysis, instrumentation, control system, quality assurance program, and testing programs. (D.C.C.)

4583 (DOCKET-50277-68) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. Final Safety Analysis Report, Amendment 23. (Philadelphia Electric Co., Pa.). 13 Nov 1972. 8p. (DOCKET-50278-68). Dep. NTIS.

Plans for conducting vibration measurements of the reactor internals during initial plant startup are presented. (H.D.R.)

4584 (DOCKET-50280-88) SURRY POWER STATION, UNITS 1 AND 2. Study to Determine if Failure of Non-Category I (Seismic) Equipment Might Potenitally Adversely Affect Safety Related Equipment. (Virginia Electric and Power Co., Richmond). 26 Oct 1972. 2p. (DOCKET-50281-77). Dep. NTIS.

4585 (DOCKET-50282-79) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Environmental Report, Errata Sheet and Page Substitutions. (Northern States Power Co., Minneapolis, Minn.). 18 Aug 1972. 39p. (DOCKET-50306-75). Dep. NTIS.

4586 (DOCKET-50282-80) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 25. (Northern States Power Co., Minneapolis, Minn.). 25 Oct 1972. 9p. (DOCKET-50306-76). Dep. NTIS.

Revised and additional data are presented concerning engineered safeguards. (D.C.C.)

4587 (DOCKET-50282-81) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Operator Prepared to Take Corrective Action Where the Potential of Flooding Engineered Safety Equipment Exists. (Northern States Power Co., Minneapolis, Minn.). 27 Oct 1972. 2p. (DOCKET-50306-77). Dep. NTIS.

4588 (DOCKET-50282-82) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Response to AEC-DL Staff Oral Questions of November 3, 1972. (Northern States Power Co., Minneapolis, Minn.). 6 Nov 1972. 53p. (DOCKET-50306-78). Dep. NTIS.

The effects of steam line ruptures on the performance of engineered safety features are discussed. (H.D.R.)

4589 (DOCKET-50286-56) INDIAN POINT NUCLEAR GENERATING UNIT 3. Applicants Environmental Report, Supplement 3. (Consolidated Edison Co. of New York, Inc., New York). 8 Nov 1972. 158p. Dep. NTIS.

Additional information is presented concerning thermal effluents from the reactor. (D.C.C.)

4590 (DOCKET-50289-75) THREE MILE ISLAND NUCLEAR STATION, UNITS 1 AND 2. Valve Wall Thickness Verification Plans and Schedule. (Metropolitan Edison Co., Reading, Pa.). 21 Jul 1972. 5p. (DOCKET-50320-34). Dep. NTIS.

4591 (DOCKET-50289-77) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Operating License Application, Amendment 33. (Metropolitan Edison Co., Reading, Pa.). 20 Nov 1972. 9p. Dep. NTIS.

Requested information is presented concerning the financial qualifications of the owners. (D.C.C.)

4592 (DOCKET-50289-78) THREE MILE ISLAND NUCLEAR STATION, UNIT 1. Final Safety Analysis Report, Amendment 34. (Metropolitan Edison Co., Reading, Pa.). 20 Nov 1972. 72p. Dep. NTIS.

Revised and requested information is presented concerning core physics, cooling system, containment system, engineered safeguards, emergency systems, safety analysis, and loss of off-site power test program. (D.C.C.)

4593 (DOCKET-50293-103) PILGRIM NUCLEAR POWER STATION. Unusual Occurrence UO-72-9. (Boston Edison Co., Mass.). 7 Nov 1972. 2p. Dep. NTIS.

An overcurrent trip of electric power center B-15 is reported. (H.D.R.)

4594 (DOCKET-50295-70) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Review for Flooding Effects. (Commonwealth Edison Co., Chicago, Ill.). 17 Nov 1972. 3p. (DOCKET-50304-70). Dep. NTIS.

4595 (DOCKET-50295-71) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Containment Pressure Time Response Analysis. (Commonwealth Edison Co., Chicago, Ill.). 20 Nov 1972. 23p. (DOCKET-50304-71). Dep. NTIS.

4596 (DOCKET-50298-56) COOPER NUCLEAR STATION. Environmental Report Supplement No. 5, Alternate Discharge Systems. (Nebraska Public Power District, Columbus). 30 Oct 1972. 16p. Dep. NTIS.

4597 (DOCKET-50298-57) COOPER NUCLEAR STATION. MSiV Wall Thickness Deficiency Report. (Nebraska Public Power District, Columbus). 8 Sep 1972. 32p. Dep. NTIS.

4598 (DOCKET-50298-58) COOPER NUCLEAR STATION. Alternate Cooling System for Cost-Benefit Analysis. (Nebraska Public Power District, Columbus). 24 Oct 1972. 15p. Dep. NTIS.

4599 (DOCKET-50302-57) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNIT 3. Concrete Void Located on Containment Structure. (Florida Power Co., St. Petersburg). 14 Sep 1972. 5p. Dep. NTIS.

4600 (DOCKET-50305-55) KEWAUNEE NUCLEAR POWER PLANT. WPS Review of Non-Category I (Seismic) Equipment. (Wisconsin Public Service., Green Bay). 31 Oct 1972. 2p. Dep. NTIS.

4601 (DOCKET-50305-56) KEWAUNEE NUCLEAR POWER PLANT. Potential Deficiences on Residual Heat Removal Pumps. (Wisconsin Public Service Corp., Green Bay). 14 Sep 1972. 2p. Dep. NTIS.

4602 (DOCKET-50309-76) MAIN YANKEE ATOMIC POWER STATION. Technical Specification Change 1. (Directorate of Licensing (AEC), Washington, D. C.). 30 Oct 1972. 3p. Dep. NTIS.

Revised technical specifications are presented concerning the minimum shutdown margin for control elements during low power physics testing. (D.C.C.)

4603 (DOCKET-50312-57) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Failure of Non-Category I Equipment Would Not Adversely Affect Category I Equipment. (Sacramento Municipal Utility District, Calif.). 24 Oct 1972. 2p. Dep. NTIS.

4604 (DOCKET-50312-58) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Final Safety Analysis Report, Amendment 17. (Sacramento Municipal Utility District, Calif.). 10 Nov 1972. 134p. Dep. NTIS.

Revised and requested data are presented concerning safety analysis, testing program, auxiliary systems, cooling system, instrumentation, core physics, and design requirements for equipment and structures. (D.C.C.)

4605 (DOCKET-50312-59) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Minimum Wall Thickness of Safety Related Valves. (Sacramento Municipal Utility District, Calif.). 17 Jul 1972. 6p. Dep. NTIS.

4606 (DOCKET-50313-57) ARKANSAS NUCLEAR ONE, UNIT 1. Acceptance of B and W Topical Reports. (Arkansas Power and Light Co., Little Rock). 25 Oct 1972. 5p. Dep. NTIS.

4607 (DOCKET-50313-58) ARKANSAS NUCLEAR ONE, UNIT 1. Final Safety Analysis Report, Amendment 31. (Arkansas Power and Light Co., Little Rock). 15 Nov 1972. 238p. Dep. NTIS.

Revised and requested data are presented concerning the safety analysis, radioactive wastes, auxiliary systems, personnel qualifications, engineered safeguards, cooling system, and design characteristics of core components. (D.C.C.)

4608 (DOCKET-50315-87) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 32. (Indiana and Michigan Power Co., New York). 31 Oct 1972. 28p. (DOCKET-50316-87). Dep. NTIS.

The final safety analysis report is amended to include the results of analyses to show the sensitivity of the peak clad temperature under loss of coolant conditions to changes in peak power density and to changes in heat transfer during reflooding. (H.D.R.)

4609 (DOCKET-50315-89) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Order Extending Completion Dates. (Directorate of Licensing (AEC), Washington, D. C.). 26 Oct 1972. 2p. (DOCKET-50316-89). Dep. NTIS.

4610 (DOCKET-50317-64) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Concrete Voids Under the Tendon Bearing Plates. (Baltimore Gas and Electric Co., Md.). 24 Oct 1972. 3p. (DOCKET-50318-61). Dep. NTIS.

4611 (DOCKET-50317-65) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Wall Thickness of Nuclear Service Valves. (Directorate of Regulatory Operations (AEC), Newark, N. J. Region I). 10 Oct 1972. 6p. (DOCKET-50318-62). Dep. NTIS.

4612 (DOCKET-50317-67) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Failure of no Non-Category I (Seismic) Equipment Would Adversely Affect the Performance of Safety-Related Equipment. (Baltimore Gas and Electric Co., Md.). 27 Oct 1972. 2p. (DOCKET-50318-64). Dep. NTIS.

4613 (DOCKET-50317-69) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 29. (Baltimore Gas and Electric Co., Md.). 13 Nov 1972. 75p. (DOCKET-50318-66). Dep. NTIS.

Revised and requested data are presented concerning containment structures, engineered safeguards, cooling systems, site, core physics, and safety analysis. (D.C.C.)

4614 (DOCKET-50320-36) THREE MILE ISLAND NUCLEAR STATION, UNIT 2. Shipping Cover Splice Plate. (Metropolitan Edison Co., Reading, Pa.). 15 Nov 1972. 2p. Dep. NTIS.

4615 (DOCKET-50321-57) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Final Safety Analysis Report, Amendment 21. (Georgia Power Co., Atlanta). 2 Nov 1972. 2p. Dep. NTIS.

4616 (DOCKET-50321-58) EDWIN I. HATCH NUCLEAR PLANT, UNIT 1. Final Safety Analysis Report, Amendment 22, Emergency Plan. (Georgia Power Co., Atlanta). 17 Nov 1972. 111p. Dep. NTIS.

4617 (DOCKET-50322-31) SHOREHAM NUCLEAR POWER STATION, UNIT 1. Weld Defects in Pressure Vessel. (Long Island Lighting Co., Hicksville, N. Y.). 19 Oct 1972. 3p. Dep. NTIS.

4618 (DOCKET-50324-60) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Installation of Instrumentation Will Prevent Adverse Flooding Affect on Class I Equipment. (Carolina Power and Light Co., Raleigh, N. C.). 26 Oct 1972. 2p. (DOCKET-50325-61). Dep. NTIS.

4619 (DOCKET-50324-62) BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2. Final Safety Analysis Report, Amendment 14. (Carolina Power and Light Co., Raleigh, N. C.). 13 Nov 1972. 225p. (DOCKET-50325-63). Dep. NTIS.

The final safety analysis report is amended by the submission of revised information. (H.D.R.)

4620 (DOCKET-50327-31) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 11. (Tennessee Valley Authority, Chattanooga). 7 Nov 1972. 22p. (DOCKET-50328-28). Dep. NTIS.

Additional information is presented concerning the design parameters of the reactor building. (D.C.C.)

4621 (DOCKET-50327-32) SEQUOYAH NUCLEAR PLANT, UNITS 1 AND 2. Construction Permits CPPR-72 and CPPR-73, Amendment 1. (Directorate of Licensing (AEC), Washington, D. C.). 22 Nov 1972. 6p. (DOCKET-50328-29). Dep. NTIS.

4622 (DOCKET-50329-33) MIDLAND PLANT, UNITS 1 AND 2. Effects of Failures in Non-Category I Equipment. (Con-

sumers Power Co., Jackson, Mich.). 31 Oct 1972. 3p. (DOCKET-50330–32). Dep. NTIS.

4623 (DOCKET-50331–60) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Amendment 8. (Iowa Electric Light and Power Co., Cedar Rapids). Nov 1972. 170p. Dep. NTIS.

Requested information is presented concerning the containment system. (D.C.C.)

4624 (DOCKET-50331–63) DUANE ARNOLD ENERGY CENTER. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Nov 1972. 227p. Dep. NTIS.

The environmental effects of construction and operation of the Duane Arnold Power Reactor are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

4625 (DOCKET-50331–64) DUANE ARNOLD ENERGY CENTER. Final Safety Analysis Report, Amendment 9. (Iowa Electric Light and Power Co., Cedar Rapids). Nov 1972. 254p. Dep. NTIS.

Revised and requested data are presented concerning core physics, containment, emergency core cooling system, electrical system, safety analysis, radioactive waste disposal system, instrumentation, structures, engineered safeguards, cooling system, and site. (D.C.C.)

4626 (DOCKET-50333–61) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Proposed Containment Atmosphere Dilution System. (Power Authority of the State of New York). 2 Nov 1972. 8p. Dep. NTIS.

4627 (DOCKET-50333–62) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Procedures for Leak Detection Drywell to Suppression Chamber. (Power Authority of the State of New York). 1 Nov 1972. 4p. Dep. NTIS.

4628 (DOCKET-50333–63) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Wall Thickness of Nuclear Service Valves. (Power Authority of the State of New York). 31 Aug 1972. 7p. Dep. NTIS.

4629 (DOCKET-50333–64) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Supplement 15. (Power Authority of the State of New York). 31 Oct 1972. 40p. Dep. NTIS.

Requested information is presented concerning the testing program, safety analysis, quality assurance program, and radioactive waste disposal system. (D.C.C.)

4630 (DOCKET-50333–65) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Action Taken to Correct Item of Nonconformance Brought to Attention Following Inspection of August 30–September 1, 1972. (Power Authority of the State of New York). 31 Oct 1972. 5p. Dep. NTIS.

Information is presented concerning personnel qualifications for the quality assurance program. (D.C.C.)

4631 (DOCKET-50333–66) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Supplement 16. (Power Authority of the State of New York. Niagara Mohawk Power Corp., Syracuse, N. Y.). 10 Nov 1972. 22p. Dep. NTIS.

Revised and requested data are presented concerning safety analysis and testing procedures for equipment and structures. (D.C.C.)

4632 (DOCKET-50333–67) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Nov 1972. 172p. Dep. NTIS.

The environmental effects of construction and operation of the James A. Fitzpatrick Power Reactor are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

4633 (DOCKET-50333–68) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Application for Licenses. (Power Authority of the State of New York. Niagara Mohawk Power Corp., Syracuse, N. Y.). 31 Dec 1968. 54p. Dep. NTIS.

4634 (DOCKET-50333–69) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Final Safety Analysis Report, Supplement 4, Additional Information. (Power Authority of the State of New York). 14 Feb 1972. 16p. Dep. NTIS.

4635 (DOCKET-50333–70) JAMES A. FITZPATRICK NUCLEAR POWER PLANT. Basic Data for Source Term Calculation. (Power Authority of the State of New York). 30 Mar 1972. 10p. Dep. NTIS.

4636 (DOCKET-50334–44) BEAVER VALLEY POWER STATION, UNIT 1. Construction Permit CPPR-75, Amendment 1. (Directorate of Licensing (AEC), Washington, D. C.). 2 Nov 1972. 3p. Dep. NTIS.

4637 (DOCKET-50334–45) BEAVER VALLEY POWER STATION, UNIT 1. Notice of Receipt of Application for Facility Operating License; Notice of Hearing; Notice of Consideration of Issuance of Facility Operating License and Opportunity for Hearing. (Directorate of Licensing (AEC), Washington, D. C.). 6 Nov 1972. 14p. Dep. NTIS.

4638 (DOCKET-50336–46) MILLSTONE POINT NUCLEAR POWER STATION, UNIT 2. Auxiliary Steam Generator Feed Pumps Vulnerable to Flooding. (Millstone Point Co., Hartford, Conn.). 26 Oct 1972. 2p. Dep. NTIS.

4639 (DOCKET-50338–53) NORTH ANNA POWER STATION, UNITS 1 AND 2. Failure of Non-Category I (Seismic) Circulating Water System Would Have Potential Adversely Affecting Some Safety Related Equipment. (Virginia Electric Power Co., Richmond). 26 Oct 1972. 2p. (DOCKET-50339–50). Dep. NTIS.

4640 (DOCKET-50342–10) VERPLANCK NUCLEAR FACILITY, UNITS 1 AND 2. Notice of Withdrawal of Application for Utilization Facility Licenses. (Directorate of Licensing (AEC), Washington, D. C.). 6 Nov 1972. 2p. (DOCKET-50343–10). Dep. NTIS.

4641 (DOCKET-50344–34) TROJAN NUCLEAR PLANT. Minimum Wall Thickness of Safety Related Valves. (Portland General Electric Co., Oreg.). 19 Jul 1972. 4p. Dep. NTIS.

4642 (DOCKET-50346–36) DAVIS–BESSE NUCLEAR POWER STATION. Effects of Non-Category I (Seismic) Equipment Failures. (Toledo Edison Co., Ohio). 30 Oct 1972. 1p. Dep. NTIS.

4643 (DOCKET-50346–37) DAVIS–BESSE NUCLEAR POWER STATION. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Nov 1972. 210p. Dep. NTIS.

The environmental effects of construction and operation of the Davis–Besse Power Reactor are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

4644 (DOCKET-50348–45) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Effect of Non-Category I (Seismic) Equipment Failure. (Alabama Power Co., Birmingham). 30 Oct 1972. 2p. (DOCKET-50364–38). Dep. NTIS.

4645 (DOCKET-50348–46) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Nonconforming Welding of Shop-Fabricated Piping. (Alabama Power Co., Birmingham). 16 Oct 1972. 6p. (DOCKET-50364–39). Dep. NTIS.

4646 (DOCKET-50352–30) LIMERICK GENERATING STATION, UNITS 1 AND 2. Wall Thickness of Nuclear Service Valves. (Philadelphia Electric Co., Pa.). 10 Oct 1972. 5p. (DOCKET-50353–30). Dep. NTIS.

4647 (DOCKET-50354–31) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Environmental Report, Amendment 3. (Public Service Electric and Gas Co., Newark, N. J.). 31 Oct 1972. 169p. (DOCKET-50355–30). Dep. NTIS.

4648 (DOCKET-50354-32) NEWBOLD ISLAND NUCLEAR GENERATING STATION, UNITS 1 AND 2. Action Taken on Item of Noncompliance Brought to Attention Following Inspection of July 7, 10-13, 1972. (Public Service Electric and Gas Co., Newark, N. J.). 25 Oct 1972. 8p. (DOCKET-50355-31). Dep. NTIS.

Additional information is presented concerning the materials used in fabricating the feedwater nozzle safe ends. (D.C.C.)

4649 (DOCKET-50361-29) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Safety Evaluation. (Directorate of Licensing (AEC), Washington, D. C.). 24 Oct 1972. 190p. (DOCKET-50362-29). Dep. NTIS.

4650 (DOCKET-50361-30) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Design Will Preclude Flooding of Safety Related Equipment. (Southern California Edison Co., Rosemead, Calif.). 20 Oct 1972. 3p. (DOCKET-50362-29). Dep. NTIS.

4651 (DOCKET-50361-31) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Environmental Report, Additional Information. (Southern California Edison Co., Rosemead, Calif.). 13 Oct 1972. 31p. (DOCKET-50362-30). Dep. NTIS.

Additional data are presented concerning transmission lines and thermal discharges. (D.C.C.)

4652 (DOCKET-50361-33) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Minimum Wall Thickness of Safety Related Valves. (Southern California Edison Co., Rosemead, Calif.). 7 Jul 1972. 5p. (DOCKET-50362-32). Dep. NTIS.

4653 (DOCKET-50363-42) FORKED RIVER NUCLEAR GENERATING STATION, UNIT 1. Design Reviewed to Determine if Failure of Any Non-Category I (Seismic) Equipment Could Adversely Affect the Performance of Safety-Related Equipment. (Jersey Central Power and Light Co., Morristown, N. J.). 26 Oct 1972. 3p. Dep. NTIS.

4654 (DOCKET-50369-31) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Adverse Affect on Performance of Safety-Related Equipment of Failure of Non-Category I Equipment. (Duke Power Co., Charlotte, N. C.). 3 Nov 1972. 2p. (DOCKET-50370-31). Dep. NTIS.

4655 (DOCKET-50376-28) AGUIRRE NUCLEAR PLANT, UNIT 1. Preliminary Facility Description and Safety Analysis Report, Amendment No. 14. (Puerto Rico Water Resources Authority, San Juan). 22 Feb 1972. 208p. Dep. NTIS.

Revised and requested data are presented concerning the reactor site, power conversion system, test program, safety analysis, instrumentation, radioactive wastes, containment system, cooling system, core physics, and performance of the emergency core cooling system. (D.C.C.)

4656 (DOCKET-50382-42) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Specific Responses to AEC Positions Regarding Proposed Instrumentation and Control Systems. (Louisiana Power and Light Co., New Orleans). 30 Oct 1972. 2p. Dep. NTIS.

4657 (DOCKET-50382-43) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Non-Seismic Class I Equipment Failure Analysis. (Louisiana Power and Light Co., New Orleans). 3 Nov 1972. 4p. Dep. NTIS.

4658 (DOCKET-50382-44) WATERFORD STEAM ELECTRIC STATION, UNIT 3. Preliminary Safety Analysis Report, Amendment 26. (Louisiana Power and Light Co., New Orleans). 17 Nov 1972. 101p. Dep. NTIS.

Revised and requested data are presented concerning safety analysis, radioactive waste systems, engineered safeguards, structures, site, and auxiliary systems. (D.C.C.)

4659 (DOCKET-50390-27) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Determination of Whether the Failure of Noncategory I (Seismic) Equipment Could Adversely Affect Safety Related Equipment. (Tennessee Valley Authority, Chattanooga). 31 Oct 1972. 4p. (DOCKET-50391-27). Dep. NTIS.

4660 (DOCKET-50390-28) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 18. (Tennessee Valley Authority, Chattanooga). 10 Nov 1972. 76p. (DOCKET-50391-28). Dep. NTIS.

Additional information is presented concerning the potential dam failure flooding of the reactor site. (D.C.C.)

4661 (DOCKET-50390-29) WATTS BAR NUCLEAR PLANT, UNITS 1 AND 2. Quality Assurance Program for Design and Construction, Additional Information. (Tennessee Valley Authority, Chattanooga). 17 Nov 1972. 7p. (DOCKET-50391-29). Dep. NTIS.

4662 (DOCKET-50395-31) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Potential Hazard to Safety-Related Equipment as a Result of Failure of Non-Seismic Components. (South Carolina Electric and Gas Co., Columbia). 25 Oct 1972. 2p. Dep. NTIS.

4663 (DOCKET-50395-32) VIRGIL C. SUMMER NUCLEAR STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 17. (South Carolina Electric and Gas Co., Columbia). 8 Nov 1972. 7p. Dep. NTIS.

Revised information is presented concerning design requirements for structures. (D.C.C.)

4664 (DOCKET-50397-30) HANFORD NO. 2 NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 14. (Washington Public Power Supply System, Richland). 1 Nov 1972. 233p. Dep. NTIS.

Revised and requested data are presented concerning construction costs, instrumentation, containment system, cooling system, site geology, safety analysis, and electrical systems. (D.C.C.)

4665 (DOCKET-50397-31) HANFORD NO. 2 NUCLEAR POWER PLANT. Program for Verification of Valve Wall Thickness. (Washington Public Power Supply System, Richland). 20 Jul 1972. 3p. Dep. NTIS.

4666 (DOCKET-50398-22) MENDOCINO POWER PLANT, UNITS 1 AND 2. Proposed Additional Offshore Geophysical Investigations. (Pacific Gas and Electric Co., San Francisco, Calif.). 27 Oct 1972. 6p. (DOCKET-50399-22). Dep. NTIS.

4667 (DOCKET-50398-23) MENDOCINO POWER PLANT, UNITS 1 AND 2. Applicant's Environmental Report, Revisions. (Pacific Gas and Electric Co., San Francisco, Calif.). 9 Nov 1972. 56p. (DOCKET-50399-23). Dep. NTIS.

4668 (DOCKET-50398-24) MENDOCINO POWER PLANT, UNITS 1 AND 2. Minimum Thickness of Safety Related Valves. (Pacific Gas and Electric Co., San Francisco, Calif.). 20 Jul 1972. 6p. (DOCKET-50399-24). Dep. NTIS.

4669 (DOCKET-50398-26) MENDOCINO POWER PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 16. (Pacific Gas and Electric Co., San Francisco, Calif.). 16 Nov 1972. 192p. (DOCKET-50399-26). Dep. NTIS.

Requested additional data are presented concerning the quality assurance program, electrical system, instrumentation, containment, site, and structures. (D.C.C.)

4670 (DOCKET-50400-27) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment 17. (Carolina Power and Light Co., Raleigh, N. C.). 2 Nov 1972. 176p. (DOCKET-50401-27; DOCKET-50402-27; DOCKET-50403-27). Dep. NTIS.

Revised and additional data on the Shearon Harris Power Reactor Units 1, 2, 3, and 4 are presented concerning safety analysis, power conversion system, auxiliary systems, electrical systems, instrumentation, engineered safeguards, structures, core physics, and site. (D.C.C.)

4671 (DOCKET-50400-28) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Failure of Non-Category I (Seismic) Piping Systems Will Not Adversely Affect the Performance of Safety Related Equipment. (Carolina Power and Light Co., Raleigh, N. C.). 26 Oct 1972. 3p. (DOCKET-50401-28; DOCKET-50402-28; DOCKET-50403-28). Dep. NTIS.

4672 (DOCKET-50400-30) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Draft Environmental Statement. (Directorate of Licensing (AEC), Washington, D. C.). Nov 1972. 174p. (DOCKET-50401-30; DOCKET-50402-30; DOCKET-50403-30). Dep. NTIS.

The environmental effects of construction and operation of the Shearon Harris Power Reactor Units 1, 2, 3, and 4 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

4673 (DOCKET-50400-31) SHEARON HARRIS NUCLEAR POWER PLANT, UNITS 1, 2, 3, AND 4. Preliminary Safety Analysis Report, Amendment 19. (Carolina Power and Light Co., Raleigh, N. C.). 22 Nov 1972. 74p. (DOCKET-50401-31; DOCKET-50402-31; DOCKET-50403-31). Dep. NTIS.

Revised and requested information is presented concerning auxiliary systems, electrical systems, structures, and containment structure pressure and temperature transient analysis. (D.C.C.)

4674 (DOCKET-50404-26) NORTH ANNA POWER STATION, UNITS 3 AND 4. Effect of Failure of Non-Category I (Seismic) Equipment on Safety Related Equipment. (Virginia Electric and Power Co., Richmond). 26 Oct 1972. 2p. (DOCKET-50405-26). Dep. NTIS.

4675 (DOCKET-50404-27) NORTH ANNA POWER STATION, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 11. (Virginia Electric and Power Co., Richmond). 10 Nov 1972. 3p. (DOCKET-50405-27). Dep. NTIS.

Additional information is presented concerning the pressure vessel material surveillance program. (D.C.C.)

4676 (DOCKET-50409-19) LA CROSSE BOILING WATER REACTOR. Incident Reports DPC-72-11 and DPC-72-12. (Dairyland Power Cooperative, La Crosse, Wis.). 19 Oct 1972. 5p. Dep. NTIS.

The failure of a control rod to drive electrically on plant startup and two unplanned reactor scrams are described. (H.D.R.)

4677 (DOCKET-50409-20) LA CROSSE BOILING WATER REACTOR. Initial Enrichment of Fuel. (Dairyland Power Cooperative, La Crosse, Wis.). 3 Nov 1972. 2p. Dep. NTIS.

4678 (DOCKET-50410-11) NINE MILE POINT NUCLEAR STATION, UNIT 2. Environmental Report, Supplement 2. (Niagara Mohawk Power Corp., Syracuse, N. Y.). 27 Oct 1972. 50p. Dep. NTIS.

4679 (DOCKET-50410-13) NINE MILE POINT NUCLEAR STATION, UNIT 2. Results of Hydraulic Model Testing Program for the Selection of a Cooling Water Discharge Design. (Niagara Mohawk Power Corp., Syracuse, N. Y.). Nov 1972. 19p. Dep. NTIS.

4680 (DOCKET-50412-1) BEAVER VALLEY POWER STATION, UNIT 2. Environmental Report, Construction Permit Stage. (Duquesne Light Co., Pittsburgh, Pa.). 6 Nov 1972. 875p. Dep. NTIS.

The environmental effects of construction and operation of the Beaver Valley Power Reactor Unit 2 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

4681 (DOCKET-50413-1) CATAWBA NUCLEAR STATION, UNITS 1 AND 2. Environmental Report (Duke Power Co., Charlotte, N. C.). 1972. 322p. (DOCKET-50414-1). Dep. NTIS.

The environmental effects of construction and operation of the Catawba Power Reactor Units 1 and 2 are examined. The descriptions include: (1) the environment in the area, including the history, geography and geology, hydrology, climatology, ecology, land and water use including chemical characteristics, (2) the facility and its effluents, (3) the impacts from construction and operation of the unit, (4) alternatives to the proposed action, (5) irreversible and irretrievable long-term commitments of resources from plant operation, (6) need for power, and (7) the benefits-cost analysis of the proposed plant operation. (D.C.C.)

4682 (DOCKET-50413-2) CATAWBA NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 1. (Duke Power Co., Charlotte, N. C.). 24 Jul 1972. 416p. (DOCKET-50414-2). Dep. NTIS.

Information is presented concerning the reactor site. (D.C.C.)

4683 (DOCKET-50413-3) CATAWBA NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 2. (Duke Power Co., Charlotte, N. C.). 1971. 565p. (DOCKET-50414-3). Dep. NTIS.

Design and performance criteria are presented for the plant structures, components, equipment and systems, the cooling system, engineered safety features, instrumentation and control, and the electric power systems. (H.D.R.)

4684 (DOCKET-50413-4) CATAWBA NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 3. (Duke Power Co., Charlotte, N. C.). 24 Jul 1972. 473p. (DOCKET-50414-4). Dep. NTIS.

Information is presented concerning auxiliary systems, steam and power conversion system, radioactive waste management, radiation protection, conduct of operation, initial tests and operation, accident analysis, technical specifications, and quality assurance program. (D.C.C.)

4685 (DOCKET-50416-1) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 1. (Mississippi Power and Light Co., Jackson (USA)). 17 Nov 1972. 376p. (DOCKET-50417-1). Dep. NTIS.

A general plant description and site characteristics are presented for the Grand Gulf Power Reactor, Units 1 and 2. The facility will be located in Claiborne County, Mississippi, on the east side of the Mississippi River. The two units are 1313 MW(e) boiling water reactors supplied by the General Electric Company. Construction of the first unit is scheduled to begin in April 1974 with commercial operation in July 1979. Operation of the second unit is planned for January 1981. (H.D.R.)

4686 (DOCKET-50416-2) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 2. (Mississippi Power and Light Co., Jackson (USA)). 17 Nov 1972. 429p. (DOCKET-50417-2). Dep. NTIS.

General design criteria are presented for the Grand Gulf Power Reactor, Units 1 and 2 structures, components, equipment, and systems. The criteria cover winds and tornados, floods, missile protection, loss of coolant accidents, and earthquake response. (H.D.R.)

4687 (DOCKET-50416-3) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 3. (Mississippi Power and Light Co., Jackson (USA)). 17 Nov 1972. 447p. (DOCKET-50417-3). Dep. NTIS.

The reactor vessel and internal components and the cooling system are described for the Grand Gulf Power Reactor, Units 1 and 2. (H.D.R.)

4688 (DOCKET-50416-4) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 4. (Mississippi Power and Light Co., Jackson (USA)). 17 Nov 1972. 289p. (DOCKET-50417-4). Dep. NTIS.

General design descriptions are presented for the Grand Gulf Power Reactor, Units 1 and 2 engineered safety features and instrumentation and control systems. (H.D.R.)

4689 (DOCKET-50416-5) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 5. (Mississippi Power and Light Co., Jackson (USA)). 17 Nov 1972. 435p. (DOCKET-50417-5). Dep. NTIS.

Instrument and component descriptions are presented for the Grand Gulf Power Reactor, Units 1 and 2 engineered safety systems, shutdown systems, display instrumentation, and control systems. (H.D.R.)

4690 (DOCKET-50416-6) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 6. (Mississippi Power and Light Co., Jackson (USA)). 17 Nov 1972. 404p. (DOCKET-50417-6). Dep. NTIS.

General design descriptions are presented for the Grand Gulf Power Reactor, Units 1 and 2 electric power systems, auxiliary systems, steam and power conversion system, and radioactive waste management systems. (H.D.R.)

4691 (DOCKET-50416-7) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 7. (Mississippi Power and Light Co., Jackson (USA)). 17 Nov 1972. 327p. (DOCKET-50417-7). Dep. NTIS.

The radiation protection features of the Grand Gulf Power Reactor, Units 1 and 2 are described, including shielding, ventilation, and the health physics program. Also described are the programs for conduct of operations and for the initial tests and operation. The potential accidents and their consequences in terms of radioactive release are analyzed. (H.D.R.)

4692 (DOCKET-50416-8) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 8. (Mississippi Power and Light Co., Jackson (USA)). 17 Nov 1972. 290p. (DOCKET-50417-8). Dep. NTIS.

Definitions of terms used frequently in the safety analysis

report for the Grand Gulf Power Reactor, Units 1 and 2 are presented. The quality assurance program to be followed during design and construction of the units is described. (H.D.R.)

4693 (DOCKET-50416-9) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 9. (Mississippi Power and Light Co., Jackson (USA)). 17 Nov 1972. 347p. (DOCKET-50417-9). Dep. NTIS.

A glossary of terms used in the safety analysis report for the Grand Gulf Power Reactor, Units 1 and 2 is presented. The plant nuclear safety operational limitations are identified, and the geological conditions at the site and in the region are described. (H.D.R.)

4694 (DOCKET-50416-10) GRAND GULF NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Volume 10. (Mississippi Power and Light Co., Jackson (USA)). 17 Nov 1972. 304p. (DOCKET-50417-10). Dep. NTIS.

The boring logs for the Grand Gulf Power Reactor, Units 1 and 2 site are presented. Safety and information guides used in the safety analysis are identified. (H.D.R.)

4695 (DOCKET-RESARA-14) [WESTINGHOUSE NUCLEAR STEAM SUPPLY SYSTEM]. Reference Safety Analysis Report, Revision 3, Amendment 1. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Systems Div.). 16 Oct 1972. 320p. Dep. NTIS.

Additional information is presented on reference Westinghouse nuclear steam supply systems to satisfy USAEC requests for more detailed data. (H.D.R.)

4696 (ORP/SID-72-4, pp 15-28) PROBLEMS IN MEETING AEC REPORTING AND COMPLIANCE REQUIREMENTS. Webster, B. H. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

The H. B. Robinson Unit Two was the first operating nuclear power plant in the Southeast U.S. and is a 200 MW(t) pressurized water plant located on a man-made cooling lake near Hartsville, S. C. Present methods for sampling, monitoring, and reporting results on effluents released from the plant are described, and the effects of the proposed AEC Safety Guide for "Monitoring and Reporting of Effluents and Environmental Levels" on the cost of the monitoring program at this reactor are discussed. (L.C.L.)

4697 (ORP/SID-72-4, pp 102-15) REGULATORY EXPERIENCE AND PROJECTIONS FOR FUTURE DESIGN CRITERIA. Gamertsfelder, C. C. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

Recent experience with the release to the environment of radioactive effluents from BWR and PWR power plants operating in the U.S. is described. Included are tabulated data for 1969 on radioactivity releases in both liquid and gaseous effluents and dose rates to individuals at given distances from these nuclear power plants. The development of more definitive criteria for radioactivity releases and computer programs for evaluating environmental contamination due to radioactivity released from future power reactors and fuel reprocessing facilities is briefly discussed. (L.C.L.)

4698 (ORP/SID-72-4, pp 194-220) PANEL DISCUSSION: INTERRELATIONSHIPS OF FEDERAL, STATE, ACADEMIC, AND INDUSTRIAL INTERESTS IN ENVIRONMENTAL STUDIES. Harward, E. D.; Johnson, W. B.; Zimmerman, R. L.; Rodgers, J. T.; Bolch, W. E.; Rhode, G. K. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

State health departments will have to increase their activities related to the public health aspects of nuclear power plants as more new plants are built. A program is outlined whereby the Bureau of Radiological Health could coordinate efforts by the state health departments, the AEC, and industry, arrange for an exchange of data between the agencies involved, provide standards to assure the uniform development of data for estimating population exposure, provide analytical quality control services, and routinely publish compiled radiological health data which would be available to all interested parties. Comments on the program by public health, power company, university, and nuclear industry spokesmen are presented. (L.C.L.)

4699 (ORP/SID-72-4, pp 221-33) NUCLEAR POWER AND A PROTECTED ENVIRONMENT. Goldman, M. I. Sep 1972.

From Southern conference on environmental protection from nuclear power plants; St. Petersburg, FL. (21 Apr 1971).

The debate over the public health and safety aspects of nuclear power plants is reviewed considering both radioactive wastes and thermal wastes. It is concluded that: the role of nuclear power in maintaining and improving our environment can be a major one, but that its full potential is being threatened by the current wave of emotionalism which some of the public agencies are abetting; more electrical energy is needed than ever before not only to continue to provide a high personal standard of living, but to provide energy to clean up our presently polluted air and water; nuclear power can provide this energy with the least overall detriment to the environment; and all concerned with nuclear power production should be convincing the public of this fact. (L.C.L.)

4700 (TID-26077) INDEXES TO ECCS HEARINGS, JANUARY 18-AUGUST 25, 1972. Bost, D. E. (Technical Information Center (AEC), Oak Ridge, Tenn.). 1 Sep 1972. 364p.

4701 (TID-26077(Suppl.1)) INDEXES TO ECCS HEARINGS (CHRONOLOGICAL SEQUENCE), JANUARY 18-AUGUST 25, 1972. (Technical Information Center (AEC), Oak Ridge, Tenn.). 1 Nov 1972. 105p.

4702 (TID-26200) INDEXES TO ECCS HEARINGS (RE-DIRECT-REBUTTAL TESTIMONY), AUGUST 25-NOVEMBER 14, 1972. Gamble, Roger (ed.) (Technical Information Center (AEC), Oak Ridge, Tenn.). 15 Nov 1972. 67p.

4703 SYSTEMATIC ASSESSMENT AND EVALUATION OF DAMAGES IN NUCLEAR POWER PLANTS. Fehndrich, W. (Rheinisch-Westfaelisches Elektrizitaeswerk AG, Essen); Feldmann, J.; Franzen, L. F.; Stoll, A. Atomwirt., Atomtech.; 17: No. 8, 431-6(Aug 1972). (In German).

From the start of nuclear energy development, sufficient provisions for damages were necessary because of the great risk potential. The prospective safety analysis, based on theoretical models of conceivable accidents, must be supplemented by other methods that are based on increased operational experience. In this connection, the systematic assessment and evaluation of damages play important roles. In West Germany, a classification system is being established for various components of power plants. Damage evaluation by the operator, the assessor, the builder, and the insuror should contribute to a safe and economical development of nuclear energy. 16 references. (tr-auth)

4704 LICENSING PROCEDURE FOR NUCLEAR POWER PLANTS. Franzen, L. F. (Technische Ueberwachungsvereine eV, Cologne). Tech. Ueberwach.; 13: No. 4, 93-100(1972). (In German).

A detailed survey is presented of the laws and regulations issued by the Federal Government in this field, whereas those of the region are treated less thoroughly. The licensing procedures for nuclear power plants encompasses the licensing in accordance with the atomic energy law, the authorization on the part of the local building authority, that by the local departments for public works, roads, and waterways, and the permission according to the industrial law. (GF)

4705 IN-SERVICE INSPECTION OF REACTORS IS KEY TO SAFE RUNNING OF NUCLEAR PLANTS. Legg, G. G. (Atomic Energy of Canada Ltd., Sheridan Park, Ont.). Elec. News Eng.; 81: No. 3, 28-9; 31; 40(Mar 1972).

The main objective of in-service inspection of CANDU-type reactors is the prevention of malfunctions which allow the release of radioactive products, constituting a hazard to public health and safety. This would mean rupture of a pressure boundary. Since extensive examinations are carried out prior to start-up, in-service inspection is intended to indicate subsequent deterioration of the system. One method of determining such deterioration is through a leak detection program. Some indications of the type of inspection program required are given by the ASME code, although the thin-wall construction found in CANDU reactors results in some differences. For multi-unit stations such as Pickering, the use of quality-control statistical techniques could be used to devise a combined inspection program. The program will be simplified by provision for good access to the areas to be inspected and easily removable insulation for at least the areas listed for primary inspection. (INIS)

4706 REACTOR EFFLUENTS: AS LOW AS PRACTICABLE OR AS LOW AS REASONABLE? Hull, A. P. (Brookhaven National Lab., Upton, N. Y.). Nucl. News; 15: No. 11, 53-9(Nov 1972).

The rationale behind the standards for radioactive effluent radiation dose levels for U.S. power reactors is discussed. Data on the release during 1970 of both liquid and gaseous radioactivities are given for U.S. power reactors. A table comparing annual probabilities of fatal injury from radiation exposure and other accidental causes is provided. Recommendation for individual and total popu-

lation exposure limits are given for the present and the future. 40 references. (J.M.J.)

4707 DISPOSAL OF WASTE WATER FROM THE NUCLEAR POWER STATION GUNDREMMINGEN/DANUBE: AN EXAMPLE FOR RADIOECOLOGICAL INVESTIGATIONS. Huebel, K.; Herrmann, H.; Ruf, M. (Bayerische Biologische Versuchsanstalt, Munich). Z. Wasser- Abwasserforsch.; 5: No. 2, 35-45 (1972). (In German).

In order to obtain basic knowledge for the protection of the population, radioecological analyses have been carried out in the river Danube using as an example the waste discharge from the 240-MW(e)-nuclear power plant at Gundremmingen. The results obtained in 1970 and extracts of former investigations are noted. Additionally by using a certain mathematical model, the consequences for the population have been calculated arising from an eventual incident causing increased radioactive waste discharge. (GF)

4708 CLUTCH SYSTEM. Havard, Jean; Mercier l'Abbe, Guy (to Commissariat a l'Energie Atomique). French Patent 2,105,636. 28 Apr 1972. Filed 15 Sep 1970. (In French).

An electromagnetically controlled mechanical clutch device intended to connect two elements such as rotating shafts is presented. The device is particularly suitable for driving the control rods of a nuclear reactor in which the positioning of the absorbing part of the rod is effected by rotation. The driven element can be instantly separated from the driving element. The absorbing part of the control rod can be disconnected in order to facilitate the drop of the safety rod. The remote control functions for all values of the couple. The transmission is integral without slip or phase shift. (France)

4709 SITING AND CONSTRUCTION OF ATOMIC POWER PLANTS. SUITABLE LOCATION FOR ATOMIC POWER PLANTS IN JAPAN. Kobayashi, K. (Tokyo Electric Power Co. Inc.). Doboku Gakkaishi; 57: No. 2, 5-12(Feb 1972). (In Japanese).

Based on expectation that the share of atomic power in total electric power supply in Japan will come to 42%, or 91500 MW, at the end of 1985, various analyses of suitable locations were made, and 77 locations, including 4 artificial islands, were chosen. Results of the analyses were: maximum permissible power output from a single station is 6000 MW due to the requirement for the prevention of successive power failure in network systems; from the view point of radioactivity, 10 km is sufficient for the distance between neighboring stations, and types of coastal locations and their associated civil engineering works can be classified into 13 standard types. Based on the shapes of coastal lines, wave height, and the necessity of constructing harbors, harbor-type open sewers are the best and most economical solution for the cooling water intake system; and, the cost effect of the length of transmission lines is important, therefore the artificial islands near big demand areas can become promising. (Japan)

4710 SITING AND CONSTRUCTION OF ATOMIC POWER PLANTS. CHARACTERISTICS OF CIVIL ENGINEERING WORKS FOR ATOMIC POWER PLANTS. Kawashima, K. (Tokyo Electric Power Co. Inc.). Doboku Gakkaishi; 57: No. 2, 13-21(Feb 1972). (In Japanese).

Various requirements for the location of atomic power plants are described with emphasis on safety problems including earthquakes and accidental radioactivity. Practice and problems in the preliminary investigation on geological, meteorological, oceanographical and seismological conditions are presented. Characteristic features of civil engineering works for the atomic power plants are discussed in detail and include: site preparation; comparison of intake and discharge systems of turbine cooling water; and the problems associated with hot discharge water. The necessity of future ecological studies and development of effective uses of the waste heat are emphasized. (Japan)

4711 SITING AND CONSTRUCTION OF ATOMIC POWER PLANTS. CONSTRUCTION MANAGEMENT IN ATOMIC POWER PLANTS. Seyama, A. (Kansai Electric Power Co. Inc., Osaka). Doboku Gakkaishi; 57: No. 2, 22-7(Feb 1972). (In Japanese).

Scale, features, and main points of civil engineering works are presented, based on experience in the construction of PWR plants. Safety practices judgement for reactors are given. The geological survey work performed and its total cost are listed. The civil engineering activities, necessary time for completion, and their costs are listed for the Mihama and Takahama stations. Problems associated with construction planning and management system are also presented. Finally, as future problems, some considerations are given on the construction of prestressed concrete containers and underground containment systems. (Japan)

4712 POWER PLANT SITING: A DETENTE? Friedlander, Gordon D. IEEE (Inst. Elec. Electron. Eng.); Spectrum; 9: No. 7, 38-9(Jul 1972).

Steam and Power Conversion System

4713 (DOCKET-50295-69) ZION STATION NUCLEAR POWER PLANT, UNITS 1 AND 2. Main Steam Safety Valve Header. (Commonwealth Edison Co., Chicago, Ill.). 26 Oct 1972. 3p. (DOCKET-50304-69). Dep. NTIS.

Propulsion and Auxiliary Power Reactors

4714 (AI-AEC-13039) SNAP REACTOR PROGRAMS PROGRESS REPORT, MAY-JULY 1972. (Atomics International, Canoga Park, Calif.). 15 Oct 1972. Contract AT(04-3)-701. 147p. Dep. NTIS.

The conceptual design and analyses of the 5-kW(e) ZrH reactor thermoelectric nuclear power system neared completion. Reactor parametric studies were performed to determine the effect of various reactor configurations on the overall system weight and performance. An 85-element core having a fuel diameter of about 1 in. and a 16-in. active length was selected for more detailed study. Hydrogen permeation measurements were performed on Hastelloy X cladding tubes. The permeation test procedure was modified to minimize the effects of surface oxidation on the permeation rate of fuel elements. The conceptual configuration of the control drive actuator was established. A system design point was selected for additional study. The net electrical power output is held constant at 5.0 kWe during the 5-y lifetime. The reactor outlet temperature increases from 1140 to 1200°F over the five years to compensate for degradation of the thermoelectric converters. A near minimum weight configuration was selected at 1785 lb with a radiator area of 246 ft^2. The preferred radiator design has aluminum fins bonded to stainless-steel coolant tubes. The fins are coated with the AI-93 emittance coating material. A single (dual throat) d-c conduction pump was selected for the primary and secondary coolant loops. Thermoelectric power modules continued on test with output power degradation rates ranging from 1.0 to 5.8% per 10,000 h for operating times up to 10,449 h, hot cladding temperatures as high as 1140°F average, and including up to 59 thermal cycles. Three new refractory-clad power modules were placed on test during the quarter, while five others were tested continuously. Major emphasis was placed on the evaluation of performance data from these modules. (auth)

4715 (CNLM-4076) USE OF Cb-1 Zr ALLOY IN THE STRUCTURAL DESIGN OF THE LCRE. Wray, Ronald (ed.) (Pratt and Whitney Aircraft, Middletown, Conn. Connecticut Advanced Nuclear Engineering Lab.). 8 Jun 1962. Contract AT(30-1)-2789. 67p. Dep. NTIS.

Declassified 31 Oct 1972.

The structural adequacy of the LCRE (Lithium-Cooled Reactor Experiment) design based on the use of Cb-1 Zr alloy as a structural material is emphasized. A complete description of the stress analysis performed on the reactor pressure vessel and core components is presented. (auth)

4716 (DOCKET-50238-95) N. S. SAVANNAH. Modification of Pier Alarm Circuit. (Maritime Administration, Washington, D. C.). 18 Oct 1972. 2p. Dep. NTIS.

4717 (LA-3237) STATUS REPORT ON IRRADIATION STUDIES OF Mo 40 v/o UO_2 CERMET FUEL. Ranken, W. A.; Salmi, E. W. (Los Alamos Scientific Lab., N. Mex.). Apr 1965. Contract W-7405-eng-36. 55p. Dep. NTIS.

Declassified 26 Oct 1972.

The thermionic reactor fuels program at the Los Alamos Scientific Laboratory has been concerned with the development of a MoUO_2 cermet fuel which will release gaseous fission products with a minimum concurrent loss of UO_2. Post-irradiation measurements of the diffusion of fission products from Mo-40 vol % UO_2 cermet have revealed that the effective diffusion coefficient of ^{132}Te increases very rapidly with the void fraction in the cermet. Long term irradiation tests of tungsten clad Mo-40 vol % UO_2 fueled thermionic emitter assemblies have been conducted in vacuum for fission power densities in the range of 250 to 350 watts per cubic centimeter and consequent temperatures in the range of 2000 to 2200°K. Measurements have also been made of UO_2 loss rate from the Mo-40 vol % UO_2 cermet. The experimental results obtained from these various tests were interpreted in terms of a

simple theoretical model of the cermet. It was concluded that: excessive loss of UO_2 from Mo–40 vol % UO_2 cermet can be prevented without reducing the fission gas release capability of fueled emitter assemblies; the irradiation lifetime of poorly vented $MoUO_2$ fueled emitter assemblies exceeds 3000 hours; and the irradiation lifetime of well vented $MoUO_2$ fueled emitter assemblies is known to approach 4000 hours, and it is predicted that it will exceed 10,000 hours. (6 references) (auth)

4718 (LA–3462) SECOND STATUS REPORT ON HIGH-TEMPERATURE IRRADIATION OF Mo UO_2 FUEL. Ranken, W. A. (Los Alamos Scientific Lab., N. Mex.). 8 Apr 1966. Contract W-7405-eng-36. 53p. Dep. NTIS.

Declassified 26 Oct 1972.

Four long-term irradiation tests have been conducted on fueled thermionic emitters fabricated by vapor deposition of a thin tungsten cladding on Mo–40 vol % UO_2 cermet cylinders. Testing was done in initial atmospheres of either argon or vacuum in both the Materials Testing Reactor (MTR) and the Omega West Reactor (OWR). Irradiation times covered the range from 5080 to 8068 hr, and the fuel-pin (fueled emitter) temperatures ranged from 1840° to 2170°K. Fuel pins irradiated for 5000 hr survived intact. Cladding cracks were observed for three of the four pins irradiated for 8068 hr, but the nature of the cracks indicates that in at least two of the three cases proper design of the free end of the fuel pin can eliminate the cracking. Dimensional increases occurred for all the pins tested with the minimum diametral increase being 1% in 8068 hr. Diametral increase appears to be a rather strong function of fuel-pin temperature, and much of the resistance to swelling appears to rest within the cermet itself rather than in the thin tungsten claddings. Enlargement of the cermet microstructure and diffusion of molybdenum into the tungsten cladding were observed, but neither effect appears to pose difficulties in thermionic applications. Introducing porosity into the cermet is effective in reducing pin swelling, but fission gas release and retention measurements indicate that as swelling occurs in fuel pins of initial low porosity the cermet changes to a configuration favoring escape of fission gases. A cylindrical hole in the center of the fuel pin was found to be effective in reducing diametral increases. It is concluded that longer fueled emitter lifetime, or reduced swelling in 5000 to 8000 hr, can be attained by introducing more initial porosity into the cermet, increasing the tungsten cladding thickness, reducing the fission power density in the fuel pin slightly, reducing the fuel-pin operating temperature, and/or using additives or increased volume fraction to strengthen the molybdenum in the cermet. (5 references) (auth)

4719 (LA–4317) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING OCTOBER 31, 1969. (Los Alamos Scientific Lab., N. Mex.). 20 Nov 1969. Contract W-7405-eng-36. 13p. Dep. NTIS.

Declassified 26 Oct 1972.

The design and the design parameters for a 100 kW(e) thermionic reactor is discussed. Details concerning drum shaped control elements are given. The design for a heat pipe radiator to cool the reactor is presented. Fabrication of W coated Mo–UO_2 ceramic thermionic fuel pins with Mo tacks brazed to the ends is discussed. Retention of ^{85}Kr in the above type fuel elements was measured. Studies on radiation effects on hardness and fracturability of Al_2O_3, Y_2O_3, and Lucalox are discussed. (J.M.J.)

4720 (LA–4375) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING JANUARY 31, 1970. PART II. (Los Alamos Scientific Lab., N. Mex.). 20 Feb 1970. Contract W-7405-eng-36. 13p. Dep. NTIS.

Declassified 26 Oct 1972.

Calculated values of reactivity and control margins for W-clad bulk UO_2 fuelled thermionic reactors are presented. A study of components and systems which can reasonably be replaced to lengthen the life of a thermionic reactor is reported. Theoretical data on the cooling of thermionic reactors are given. Methods for fabricating tungsten-coated Mo–UO_2 cermet fuel pins are described. Fission gas bulk behavior in irradiated tungsten-coated Mo–UO_2 cermet fuel pins is described. Diffusion of W cladding into Mo–UO_2 fuels, and the subsequent formation of Mo–W solid solutions is discussed. Thermal diffusivities and conductivities for irradiated Al-995, Lucalox, and Y_2O_3 were determined. (J.M.J.)

4721 (LA–4447) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING APRIL 30, 1970. PART II. (Los Alamos Scientific Lab., N. Mex.). May 1970. Contract W-7405-eng-36. 17p. Dep. NTIS.

Declassified 26 Oct 1972.

Results of core physics calculations for several configurations of different fuels for a 100 kW(e) thermionic reactor are presented. Fabrication methods and properties are given for W-clad Mo–UO_2 cermet thermionic reactor fuel pins. Fission gas bubble measurements were made in irradiated W-clad Mo–UO_2 fuel pins. Radiation effects on various types of Al_2O_5, Y_2O_5, and Lucalox ceramics are detailed. The use of molten lead as a hydrogen barrier for a zirconium hydride moderator in a thermionic reactor is evaluated. (J.M.J.)

4722 (LA–4497) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING JULY 31, 1970. (Los Alamos Scientific Lab., N. Mex.). Aug 1970. Contract W-7405-eng-36. 12p. Dep. NTIS.

Declassified 26 Oct 1972.

Fast neutron radiation effects on Y_2O_3, Al_2O_3, and Lucalox are reported. Tungsten coated Mo–UO_2 cermet thermionic reactor fuel pins were redesigned to eliminate thermal instability. Data on elastic moduli and thermal expansion coefficients for Mo–UO_2 cermets are given. (J.M.J.)

4723 (LA–4625) QUARTERLY STATUS REPORT ON THE SPACE ELECTRIC POWER R AND D PROGRAM FOR THE PERIOD ENDING JANUARY 31, 1971. (Los Alamos Scientific Lab., N. Mex.). Feb 1971. Contract W-7405-eng-36. 7p. Dep. NTIS.

Declassified 26 Oct 1972.

A heat-pipe-cooled reactor design using either UC or UN fuel was investigated. The main advantage of this system is an operating temperature that is high enough for the reactor to be used in conjunction with a Brayton-cycle turbine. Criticality studies show that the reactor diameter could be as small as ~8.5 in. at a core length of 13.0 in., which would result in a radiation shield of minimum weight. Nine Mo-60 v/o UO_2 cermet fuel pins were fabricated and will be irradiation-tested in the Engineering Test Reactor (ETR). Emitters have been calibrated in the Omega West Reactor (OWR) by measuring their temperature as a function of reactor power and then performing a radiochemical fission analysis to determine the relation of fission-power density in the emitters to reactor power and thence to emitter temperature. The 27 specimens of various insulator materials and seals which are undergoing irradiation tests in the EBR-II reactor have accumulated 80% of their desired neutron fluence. Resistivity tests of several sheathed insulators are being conducted, both in-pile and out-of-pile. The samples are held at 750°C while a current of 100 Vdc is applied to the outer insulating layer. The resistivity of the unirradiated sheathed insulators increased for ~400 h until it equaled that of metallized ceramic insulators, whereas the resistivity of irradiated sheathed insulators slowly decreased. The tests are continuing. (auth)

4724 (NAA-SR-6320(Vol.4)) MERCURY RANKINE PROGRAM (SNAP 2). DEVELOPMENT OF LIQUID-MERCURY-LUBRICATED BEARINGS. VOLUME IV. THREE-SECTOR BEARING EXPERIMENTAL RESULTS. Decker, O. (TRW Equipment Labs., Cleveland, Ohio). [nd]. Contract AT(11-1)-Gen-8. 222p. Dep. NTIS.

For Atomics International, Canoga Park, Calif.

Declassified 3 Nov 1971.

The development of the hybrid three-sector bearings with and without orifice compensation is described. On the basis of previous development work and the system requirements, the three-sector bearing is selected, sized, analyzed, and tested. The initial tests utilize inherent compensation and several supply configurations. Diametral clearance, axial length, and alignment are the principal variables experimentally evaluated. The overall performance characteristics reviewed are satisfactory except for poor stability characteristics. The reduced data is utilized to modify the supply pad configuration and orifice diameter resulting in partial orifice compensation. Improved stability characteristics are achieved at the expense of load capacity and flow for a given supply pressure. To improve stability performance further, complete orifice compensation is utilized. Combined with a diametral clearance of 0.0015-inch, complete orifice compensation assures freedom from half-frequency whirl over the entire speed and load range. Experimental performance for each type of three-sector bearing tested is compared with predicted performance based on semi-empirical turbulent flow correction factors. The three-sector bearing meets the major CRU requirements with the following exceptions: without orifice compensation the threshold of half-frequency whirl is below the design speed, and with orifice compensation the load capacity is compromised. (auth)

4725 (NAA-SR-9892) SNAP 10A POWERED METEOROLOGICAL SATELLITE STUDY. (Atomics International,

Canoga Park, Calif.). 15 Jun 1964. Contract AT(11-1)-Gen-8. 141p. Dep. NTIS.
Declassified 5 Nov 1971.

A study has been conducted to determine the applicability of reactor-powered SNAP systems for advanced Operational Meteorological Satellites (OMS). The advanced OMS systems currently being planned for operation in the 1970's would carry highly redundant electronic payloads to permit satellite lifetimes of 3 to 5 yr. The complete meteorological payload weight would be in the range of from 1300 to 1600 lb and the power requirements are estimated to be from 600 to 1600 W. The orbital altitude for the OMS is 1500 n. mi, so the payloads will have to be protected by an aluminum shield and radiation "hardened" to withstand the Van Allen radiation encountered at this altitude. The weight of advanced operational nuclear power systems, based on extrapolation of the SNAP 10A concept and using the SNAP 2 reactor would range from approximately 800 lb at 500 W, to 1500 lb at 2.5 kWe, including sufficient shielding to reduce the fast neutron dose to one-seventh that of the high energy Van Allen protons. Operation of these systems with passive control for more than 3 yr is feasible for power levels up to 1500 watts. By using a more advanced reactor concept with a smaller shieldable volume, the power system weights could be reduced another 120 to 140 lb. It is shown that SNAP 10A powered satellites could meet the advanced OMS system payload and power requirements using a standard Atlas/Agena launch vehicle, and with a floxed Atlas/Agena another 900 lb of payload could be accommodated. The optimum configuration for such a satellite is also ideal for a passive stabilization system based on the gravity gradient principle. (auth)

4726 (PWAC-200) ENGINEERING DESIGN STATUS REPORT ON THE PWAR-5A TEST REACTOR, MARCH 15, 1958. (Pratt and Whitney Aircraft, Middletown, Conn.). [nd]. 365p. Dep. NTIS.
Declassified 31 Oct 1972.

Engineering, design, and physics information for the solid-fuel sodium-cooled test reactor (PWAR-5) is presented. Design criteria, reactor core, coolant loops, materials, shielding, control and instrumentation, and critical experiments are considered. (W.D.M.)

4727 CORE DESIGN OF THE REACTOR FOR THE NUCLEAR SHIP OTTO HAHN. Buenemann, D. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt mbH, Hamburg); Kolb, M.; Henssen, H.; Mueller, E.; Rossbach, W. Advan. Nucl. Sci. Technol.; 6: 1-44(1972).

The general design aspects of the Otto Hahn nuclear merchant ship are listed and the reactor power plant is described. The reactor core, nuclear and thermohydraulic characteristics, zero power experiments, and operating experience are discussed in detail. 39 references. (H.D.R.)

4728 ON-LINE DIGITAL COMPUTER CONTROL OF THE NERVA NUCLEAR ROCKET ENGINE. Kendrick, Larry Ellis. Tucson, Ariz.; Univ. of Arizona (1972). 197p. University Microfilms Order No. 72-18,965.
Thesis.

The problem of on-line digital computer control of the NERVA nuclear rocket engine is considered. NERVA operates in the following manner. Liquid hydrogen is removed from a storage tank by a turbopump and pumped into a nuclear reactor. The hydrogen is heated in the reactor and exhausted from the engine nozzle to provide thrust. Energy to drive the turbopump is also derived from the reactor. Design objectives call for a thrust of 75,000 pounds. The physical complexity of the system is reflected in the differential equations description of the engine dynamics in that the describing equations are high order, nonlinear, and tightly coupled. The study proposes the method of State Dependent State Variable Feedback (SDSVF) as a practical approach to the control of NERVA and other complex nonlinear and/or time-varying systems. The difficulties inherent in other design methods are avoided by defining the optimal closed loop system in terms of a desired transfer function, rather than a performance index to maximize or minimize. Selection of a desired closed loop transfer function in the nonlinear and/or time-varying case is made possible by treating the system as a sequence of state and/or time dependent linear constant coefficient systems. These linear models are computed on-line by a digital computer. Each linear model has its own set of constant state variable feedback coefficients (also computed on-line) necessary to realize the desired closed loop transfer function. Thus, a sequence of state variable feedback coefficients is calculated to provide state dependent state variable control. A linearization method is developed and a control design method is chosen. It is shown that these procedures are easily programmed on a digital computer and that they are suitable for on-line computation. The method is first illustrated by a simple example involving the control of a system described by Van der Pol's Equation. Although only second order the example is nontrivial since the plant to be controlled is inherently unstable. The SDSVF method of control is then applied to the problem of controlling NERVA. NERVA has not been constructed, so that on-line control experiments were performed on the Common Analog Model (CAM) of NERVA. The CAM is a 52nd order hybrid simulation of NERVA and is not suitable for control analysis because of its high order and complexity. Models of nuclear rocket engines available from the literature do not adequately represent NERVA, and hence the Simplified Nonlinear Model (SNM) of NERVA is developed. This model is then used to design an on-line digital computer control system for the Common Analog Model of NERVA. A series of control experiments show that SDSVF control provides adequate control of the NERVA engine over a wide operating range for various types of input demands. (Diss. Abstr. Int., B)

4729 MINIMUM TIME THRUST START-UP OF A NUCLEAR ROCKET WITH INTEGRO-DIFFERENTIAL CONSTRAINTS. Pym, J. W.; Shen, C. N. Automatica; 8: No. 2, 153-61(Mar 1972).

The minimum time thrust start-up of a nuclear rocket gives rise to an optimal control problem where the state representing the exhaust propellant must satisfy an integro-differential equation and an inequality constraint. It is shown that by defining an appropriate Hamiltonian function, Pontryagin's Maximum Principle can be applied. The result is proved by reformulating the problem as one in the calculus of variations of minimizing a functional subject to various constraints including the two constraints mentioned above. The necessary conditions for a minimum so derived can be translated into those for a maximum principle type formulation. The results of the analysis are applied to show that boundary control is obtained for the particular problem of the nuclear rocket. (auth)

4730 DYNAMICS MODEL OF THE COAXIAL FLOW GASEOUS CORE NUCLEAR REACTOR SYSTEM. Turner, Kyle Hugh. Atlanta; Georgia Inst. of Tech. (1971). 115p. University Microfilms Order No. 72-19,712.
Thesis.

A mathematical model was derived for the coaxial flow gaseous core nuclear reactor system. The equations were derived from elementary neutron, heat, and mass balances on the components of the system and from correlations presented in the work of Ragsdale, Parks and Lane, and Patch. Propellant flow out of the reactor cavity was assumed to be governed by the choked-flow equation. The net radiant heat transfer between the fuel and propellant was calculated by defining effective black-body radiating temperatures which yield the correct heat fluxes at normal operating conditions. Average properties were assumed to sufficiently describe the state of the reactor; no spatial variations were taken into account. Reactivity mechanisms which were considered included changes in fuel mass, fuel temperature, fuel cloud radius, propellant density, propellant temperature, and moderator temperature. The system response for positive reactivity insertions, perturbations in the propellant and fuel flow rates at the cavity inlet, and for termination of the moderator primary coolant flow was predicted. The predictions indicate that the reactor is not inherently stable, but the response to positive reactivity insertions is considerably more sluggish than for an equivalent system with no reactivity feedback. Decreases in propellant flow rate at the cavity inlet resulted in a fairly rapid power increase whereas termination of the fuel injection and moderator primary coolant flow rate caused a reactor shutdown. For all the cases in which the power level rose, the time scale for the reactor to reach conditions which might cause system damage is long enough so that present control technology can be invoked to control the reactor. The model is slightly sensitive to variations in the propellant and fuel temperature coefficients of reactivity and quite sensitive to variations in the propellant density and fuel cloud radius coefficients. Changes in fuel mass and moderator temperature coefficients have virtually no effect on the model. Changing the rate at which fuel is lost as the fuel volume fraction increases also does not affect the model's predictions. The best of the proposed control systems seems to be the concept of control drums in the moderator region. Regulation of the fuel injection rate does not give reactivity insertions fast enough to limit most transients, and regulation of the propellant injection rate was found to be good only for shutdown of the reactor—any change in propellant inlet flow rate introduces fairly large changes in reactivity. (Diss. Abstr. Int., B)

4731 RADIATION MONITORING EQUIPMENT OF THE ATOMIC-POWERED SHIP "MUTSU" AND ITS HOME-HARBOR. Nikaido, S. (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen; No. 92, 2313-20(Jun 1971). (In Japanese).

The radiation monitoring in the vicinity of the atomic-powered ship "Mutsu" consists of radiation monitoring of the "Mutsu"

itself, of servicing facilities on shore, and of the environment near the servicing facilities. The basic thought, methods and equipments of radiation monitoring are the following. The ship and attached establishments on land are divided into controlled areas, observed areas of surroundings, and other areas. The radiation monitoring includes the off-limits inspection, the check of persons coming in and out, personnel irradiation monitoring, measurement of a radiation dose in the ship and shore facilities, and calibration of a measurement equipment. The radiation monitoring equipment on the ship, includes a health physics room, a dressing room, a shower room, a sampling room, and a measurement room. The radiation monitors are classified as a fixed area monitor and a gas dust water monitor. In shore facilities, the radiation monitoring equipment is mainly installed in a fuel exchange house, and other equipment is placed in the radiation monitoring rooms, shower rooms, dressing rooms, analysis rooms, and measurement rooms. The radiation monitors on land involve fixed area monitors, semi-fixed area monitors, and emergent radiation measurement equipment. (Japan)

4732 CRITICALITY EXPERIMENT ASHORE FOR NUCLEAR SHIP "MUTSU". Shimooke, T. (Japan Nuclear Ship Development Agency, Tokyo). Genshiryokusen; No. 92, 2327-9(Jun 1971). (In Japanese).

Before fuel is loaded on the NS Mutsu, criticality test on land is performed with fuel and control rods for the ship. This criticality test is performed in order to make plan of fuel loading and load test, to perform the test which is difficult on the ship, to increase the efficiency and economy of the test on the ship, and to confirm design values regarding performance and safety. This test is divided into next 11 parts: (1) fuel loading test—subcritical degree is measured at each step, and knowledge of the criticality of new fuel is obtained experimentally; (2) measurement of stuck control rod margin—condition of rod stick is produced, and negative reactivity is measured by pulsed neutron technique; (3) shut-down margin—shut-down margin is confirmed to be more than a standard value; (4) measurement of excess reactivity—when all control rods are withdrawn, reactivity is measured by liquid poison technique; (5) measurement of equivalent reactivity of control rods; (6) comparison between measured power distribution and design distribution; (7) measurement of temperature coefficient of moderator; (8) measurement of reactivity effect of the liquid poison; (9) test of response characteristics of a neutron detector; (10) measurement of uniformity of each fuel assembly, and (11) measurement of uniformity of the reactivity of control rods. (Japan)

Process Heat and Desalination Reactors

Refer also to abstract 4395.

4733 (CONF-721109-6) ADVANCED GAS-COOLED REACTOR SYSTEMS. Insch, G. M. (British Nuclear Design and Construction Ltd., Whetstone (England)); Trauger, D. B. (Oak Ridge National Lab., Tenn.). [nd]. 6p. Dep. NTIS.

From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

The operating experience of prototypes and construction experience for advanced gas-cooled reactors, including the AGR in the UK and HTGR's in the UK, US, and West Germany, are described. The likely requirements for thermal reactors during the next decade are reviewed. The ability of the systems to meet these requirements is assessed. It is concluded that, in the past, thermal reactors have been required to provide heat for steam generation, and their effectiveness has been judged largely on the basis of the cost of the resultant electrical power. In the future the effects of thermal efficiency, fuel utilization, environmental acceptability and other requirements on the power cost will become more important. Because of this the HTGR seems well placed to provide an increasing contribution to the production of heat and electricity in the world. (L.C.L.)

4734 (ORNL-4769) NUCLEAR DESALINATION PROGRAM ANNUAL PROGRESS REPORT ON ACTIVITIES SPONSORED BY THE ATOMIC ENERGY COMMISSION FOR PERIOD ENDING OCTOBER 31, 1971. Anderson, T. D.; Gill, A. B. (comps.) (Oak Ridge National Lab., Tenn.). Nov 1972. Contract W-7405-eng-26. 35p. Dep. NTIS.

Cost-benefit studies indicated that certain auxiliary systems would be worthwhile additions to large dual-purpose plants. These included a bypass steam system and an auxiliary condensing system which appear to significantly improve plant availability and flexibility. An investigation was made on the possibility and consequences of radioactive materials entering the evaporator from the nuclear power plant. It was concluded that the public health and safety can be adequately protected by proper design of the interface between the steam supply and the evaporator. Digital simulator studies showed that multistage flash (MSF) evaporator stability is dependent on the method of coupling to the energy source as well as evaporator plant design features. The water resources and alternatives for the California region, and supplemental water sources for the New York metropolitan region were reviewed. The key to the successful use of relatively expensive desalted water in agriculture appears to be improved water use efficiency such as a low-cost subsurface irrigation system. 66 references. (auth)

Research and Test Reactors

Refer also to abstracts 2586, 2901, 3024, and 4418.

4735 (AEEW-M-997) SPECTRUM MEASUREMENTS IN FAST REACTOR ASSEMBLIES. Broomfield, A. M.; Paterson, W. J.; Sanders, J. E. (Atomic Energy Establishment, Winfrith (England)). Oct 1970. 43p. (CONF-701154-1). Dep. NTIS (U. S. Sales Only).

From Meeting on fast reactor spectrum measurements and their interpretation; Chicago, IL. (10 Nov 1970).

Techniques used for the measurement of neutron energy spectra in the fast reactor assemblies VERA (Aldermaston) and ZEBRA (Winfrith) are reviewed including time-of-flight, proton-recoil, lithium-6 and double-scintillator spectrometers. Results of some recent measurements are presented and compared with theoretical prediction. (25 references) (auth)

4736 (ANCR-1082) ATRC SAFETY ANALYSIS REPORT. SUPPLEMENT-1 OF IDO-16950-1. Knight, D. W.; Kaufman, N. C. (Aerojet Nuclear Co., Idaho Falls, Idaho). Sep 1972. Contract AT(10-1)-1375. 12p. Dep. NTIS.

A supplement to the original ATRC Safety Analysis Report (SAR) is presented. It provides the basis for those revised requirements and conclusions incorporated in the new Technical Specifications. The areas considered are: maximum credible accidental reactivity insertion; reactor operating power level and trip level for the Neutron Level Subsystem; permissible ramp reactivity insertion rates; hold-down reactivity requirements; shutdown reactivity requirements; definition of major incident; and unreliability requirements of Neutron Level and Safety Rod Subsystems. 8 references. (auth)

4737 (ANL-7471) FINAL SAFETY ANALYSIS REPORT ON THE ZERO POWER PLUTONIUM REACTOR (ZPPR) FACILITY. Lawroski, H.; Palmer, R. G.; Thalgott, F. W.; Curran, R. N.; Matlock, R. G. (Argonne National Lab., Ill.). Jun 1972. Contract W-31-109-eng-38. 148p. Dep. NTIS.

The Zero Power Plutonium Reactor (ZPPR) is a split-table-type critical facility operated by Argonne National Laboratory at the National Reactor Testing Station (Idaho) in support of the AEC's Liquid Metal Fast Breeder Reactor (LMFBR) Program. The ZPPR is designed for the study of the physics of power breeder systems and is capable of simulating fast-reactor compositions characteristic of the proposed 300-500-MW(e) demonstration plants and 1000-MW(e) commercial plants. This simulation is accomplished either by using fuel, coolant, and structural materials in the form of small plates stacked into drawers, or by employing fuel rods inserted into calandria assemblies. The facility, the management philosophy used to ensure safety, and the reactor operating procedures are described. A safety evaluation of the facility and its systems is included. As part of the safety evaluation, a maximum credible accident and a hypothetical, incredible accident were calculated to demonstrate the capability of the containment structure. They both led to the conclusion that operation of the ZPPR will not cause undue risk to the health and safety of employees or to the general public. 32 references. (auth)

4738 (ANL-7829) EBR-II MARK IIB OSCILLATOR ROD AND ITS DRIVE. Pardini, J. A.; Seim, O. S.; Thompson, W. M.; Natoce, J. T.; Hutter, E. (Argonne National Lab., Ill.). Nov 1971. Contract W-31-109-eng-38. 52p. Dep. NTIS.

The Mark IIB oscillator rod enables measurement of reactor transfer functions by rotating an absorber material (boron carbide) toward and away from the center of the reactor to perturb reactivity. Its design has eliminated two operating problems encountered with previous EBR-II oscillator rods: bowing and consequent rubbing of the rod in its guide tube, and failure of the seals that prevent air from contacting the sodium coolant. The Mark IIB rod and its drive were installed in EBR-II in April 1971. Both have performed satisfactorily since then. (auth)

4739 (ANL/EBR-62) EVALUATION OF THE EBR-II FUEL-HANDLING COMPLETE CIRCUIT. EBR-II Project. Haroldsen, R. O.; Curran, R. N. (Argonne National Lab., Ill. Argonne National Lab., Idaho Falls, Idaho). Mar 1972. Contract W-31-109-Eng-38. 29p. Dep. NTIS.

The fuel-handling complete (FHC) circuit of EBR-II has been evaluated as part of a larger effort on upgrading the plant protective system. The FHC circuit monitors 36 separate parameters. The reactor and primary pumps are subject to shutdown from any of the parameters monitored. The primary purpose of the monitors is to ensure that fuel-handling operations are properly terminated before reactor operations are undertaken. Equivalent protection can be obtained by modifying the circuit to enforce proper procedure in terminating fuel-handling operations without spurious reactor and pump trips. (auth)

4740 (CONF-721024-2) EDDY-CURRENT EVALUATION OF NUCLEAR CONTROL RODS. Dodd, C. V.; Smith, J. H.; Simpson, W. A. (Oak Ridge National Lab., Tenn.). [nd]. 30p. Dep. NTIS.

From 32nd national conference of the American Society for Nondestructive Testing; Cleveland, OH. (16 Oct 1972).

An eddy-current technique was developed and performed to detect cracks and measure thickness of cladding and oxide thickness on new and used nuclear control rods for the High Flux Isotope Reactor at the Oak Ridge National Laboratory. A computer design was performed for coils to maximize sensitivity to surface cracks and cladding thickness variations and minimize effects due to lift-off and temperature variations. In spite of radiation levels measured to be 10^5 R/h at 1 ft from the surface and temperature variations of 5°C on used control rods, flaws as small as 0.001 in. were detected and the cladding thickness was measured to within 0.001 in. (auth)

4741 (DOCKET-50139-2) UNIVERSITY OF WASHINGTON NUCLEAR REACTOR. Regulatory Operations Investigation Report 7201. (Directorate of Regulatory Operations (AEC), Berkeley, Calif. (USA). Region V). 6 Nov 1972. 52p. Dep. NTIS.

4742 (DOCKET-50231-126) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Technical Specifications, Proposed Change 15. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Dept.). 31 Oct 1972. 27p. Dep. NTIS.

Proposed changes in technical specifications are presented concerning the plant security system and radiation monitoring program. (D.C.C.)

4743 (FRNC-TH-269) USE OF OPTIMIZING AUTOMATIC SYSTEMS TO CONTROL EXPERIMENTAL DEVICES IRRADIATED IN A NUCLEAR REACTOR. APPLICATION TO THE CONTROL OF THE EIGHT FUEL IRRADIATION LOOPS OF THE PEGASE REACTOR. Guintrand, Claude (Aix-Marseilles Univ. (France)). 1972. 137p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Independently operating control units were developed from previously conducted research aimed at developing an optimum automatic control system for the experimental part of the Pegase reactor. The second stage of the program consisted of developing an optimum self-adapting control system for the experiments, this system being in the form of a centralized control unit with an on-line real time computer. The temperature control of the Pegase irradiation loops, which were represented by a nonlinear third order system, was studied using topological methods, in three dimensional phase space. Optimum control theory enabled the safety requirements of the installation to be taken into account. A special signal is used, which increases the reliability of the equipment by ensuring a smoother running. A simplified mathematical model was developed which considerably reduces the number of calculations necessary to establish the optimum control law. (auth)

4744 (LFEN-NI.-73-a) ECONOMIC STUDY OF FUEL UTILIZATION IN A SWIMMING POOL NUCLEAR REACTOR. Costa Oliveira, J. M. (Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1972. 19p. (In Portuguese). Dep. NTIS (U. S. Sales Only).

4745 (LIB/Trans-435) CRITERIA FOR COMPARISON OF HIGH FLUX RESEARCH REACTORS. Tsykanov, V. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). Translated by E. Meller (Australian Atomic Energy Commission), from report SRARI-102. 12p. Dep. NTIS (U. S. Sales Only).

The criteria for the comparison of the research reactors of various types with high neutron fluxes, intended substantially for specimen irradiations with neutron absorption in them, are proposed. The comparison of the high-flux reactors of two types (with light water and neutron trap, with heavy water and low fuel concentration in the core) is given and the conclusion is drawn about their application depending on operation program. (auth)

4746 (ORNL-MIT-46) ERROR ANALYSIS FOR IN-PILE MEASUREMENT OF UO_2 FUEL TEMPERATURE AT 2200°C. Gnecco, M.; Michel, J. H. (Massachusetts Inst. of Tech., Oak Ridge, Tenn. (USA). School of Chemical Engineering Practice). 1 Mar 1968. 31p. Dep. NTIS.

An error analysis for the in-pile measurement of UO_2 fuel temperature at 2200°C was carried out to determine the accuracy of a future experiment in the Materials Test Reactor (MTR) at Idaho Falls. The main source of error was the change in the temperature profile in the fuel capsule, due to the introduction of the thermocouple probe. Preliminary calculations on a digital computer indicate that this error will be several hundred C°. Out-of-pile experiments with beryllia- and thoria-insulated W/W25Re thermocouples were conducted. Up to the maximum temperature attained of 2300°C, beryllia proved to be a better electrical insulator. Use of beryllia led to negligibly small errors, whereas use of thoria insulator led to significant errors in the measured emf above 1800°C due to the decrease of electrical resistivity of thoria at these temperatures. Minor effects in a gas tight seal, which the thermocouple wires go through, and those in the lead wires were also taken into consideration. 12 references. (auth)

4747 (SC-DC-721414) MEASURED AND CALCULATED NEUTRON SPECTRA IN THE EXPERIMENTAL CAVITY OF THE ACPR. Croucher, D. W.; Lucoff, D. M.; Schmidt, T. R.; Reil, K. O.; White, J. R. (Sandia Labs., Albuquerque, N. Mex.). 1972. 6p. (CONF-721109-3). Dep. NTIS.

From American Nuclear Society international meeting; Washington, D. C. (12 Nov 1972).

Details of the detectors used are listed in a table. A curve of the comparative neutron spectra is included. (7 references) (J.M.J.)

4748 FAST NEUTRON SPECTRUM AND FEW GROUP CONSTANTS FOR THE UA-RR-1 REACTOR. Nassar, S. F.; Gaafer, M. A.; El-Cherif, A. I. (Atomic Energy Establishment, Inshas, Egypt). J. Nucl. Energy; 26: No. 10, 517-21(Oct 1972).

B-1 and P-1 multigroup equations were used to solve for group flux and group current in the energy range 0.625 eV-10 MeV, in order to obtain a realistic neutron energy distribution in the UA-RR-1 core. Removal of neutrons by anisotropic scattering, inelastic scattering and self-shielded resonance capture and fission were taken into account. (UK)

4749 FALSE REACTOR PERIOD SCRAMS DURING START-UPS. Palabrica, R. J. (Philippine Atomic Research Center, Diliman). Philipp. Nucl. J.; 2: No. 2, 241-2(1970).

A problem of false period scrams during startup of the University of Virginia Research Reactor following full power shutdowns is described. It was found that fully compensating the ionization chamber associated with the period measuring circuit greatly reduced the incidence of false scrams under the above conditions. (H.D.R.)

4750 FFTF SITE AND CONSTRUCTION. Simmons, A. A. (Hanford Works, Richland, Wash.). Nucl. Eng. Int.; 17: No. 195, 615-16(Aug 1972).

A brief account is given of the FFTF site at Benton County, near Richland, and of the major structures including the reactor containment building, the reactor service building, and the control room. Brief reference is made to auxiliary buildings and dump heat exchanger structures. (UK)

4751 ROLE OF FFTF IN THE US LMFBR PROGRAMME. Shaw, M. (Atomic Energy Commission, Washington, D. C.). Nucl. Eng. Int.; 17: No. 195, 613-14(Aug 1972).

A brief outline is given of US activities in the breeder reactor field, and the resulting development of the Fast Flux Test Facility, designed for testing fuels and materials for future sodium cooled fast breeder power reactors. The testing capabilities of the FFTF and its functions in relation to the LMFBR program are summarized. (UK)

4752 FFTF REACTOR AND COOLANT SYSTEM. Werle, J. E. (Hanford Works, Richland, Wash.); McGough, C. B.; Edwards, P. A.; Selz, A. Nucl. Eng. Int.; 17: No. 195, 619-22(Aug 1972).

The sodium-cooled PuO_2-UO_2 fueled FFTF fast test reactor will provide a maximum neutron flux of 7×10^{15} n/cm^2/s. The reactor will perform irradiation testing in up to six independently cooled test channels or "closed loops," and also in instrumented "open loop" test channels cooled by the reactor primary coolant. The coolant system consists of three 133 MW(t) loops each providing 14,500 gpm of sodium flow and rated at 1050°F. Heat rejection is

by sodium-to-air dump heat exchangers. The reactor and coolant system are fully described and parameters are listed. (auth)

4753 FUEL AND CORE COMPONENT HANDLING. Boyd, C. L. (Hanford Works, Richland. Wash.); Harbison, S. G.; Sanders M. K. Nucl. Eng. Int.; 17: No. 195, 623-5(Aug 1972).

The fuel handling cycle of the FFTF is described and details are presented of the machines and facilities used in the transfer and handling of fuel and test fuel assemblies. Three handling machines are positioned in the reactor vessel head. A cooled closed loop ex-vessel machine transfers the fuel to and from the reactor. A bottom loading transfer flask incorporating gag cooling is used to transfer, through containment, fuel assemblies from an interim decay storage unit to the sodium removal station and finally to the cask loading station for off-shore shipment. An interim examination/maintenance cell provides for early non-destructive examination, within containment, of irradiated core components. (UK)

4754 FUEL. COMPONENT DESIGN, AND TECHNOLOGY. Cerni, S.; Last, G. A. Nucl. Eng. Int.; 17: No. 195, 617-18 (Aug 1972).

The FFTF is fueled with PuO_2-UO_2 in 316 stainless steel and is designed for a peak burnup of 80,000 MWd/te. Details are given of the fuel pin and attention is given to the strain limits and wastage allowance of the cladding. The position relating to the commercial production of fuel is briefly discussed and an outline is given of irradiation testing of fuels and materials in progress in EBR-II, in support of FFTF. (UK)

4755 UNIT FOR INVESTIGATING THERMAL CONDUCTIVITY OF MATERIALS UNDER CONDITIONS OF REACTOR IRRADIATION. Kolyadin, V. I.; Kharlamov, A. G.; Batalov, A. A. High Temp. (USSR) (Engl. Transl.); 10: No. 1, 190-1(1972).

Translated from Teplofiz. Vys. Temp.; 10: No. 1, 211-13(1972).

A working channel is described for investigating materials in a water-cooled reactor. The loop-type unit described permits measuring the thermal conductivity of various construction materials in a temperature range up to 500°C in fields of reactor irradiation. Results of measurements for Be are given. (M.O.W.)

4756 IMPROVEMENTS ON FISSION GAS RELEASE LOOP. Shiba, Koreyuki; Handa, Muneo; Yamagishi, Shigeru; (and others) (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 14: No. 7, 331-6(Jul 1972). (In Japanese).

Improvements made on the Fission Gas Release Loop from 1965 to 1970 are reported. These include the development and installation of a cartridge-type specimen chamber, an automatic flow controller and automatic sampling-measuring equipment, as well as the installation of oxygen and water vapor analyzers. The performance of the safety systems during loop operation is also described. (9 references) (auth)

4757 NUCLEAR MEASUREMENTS PROCEDURES FOR THE DESIGN AND MONITORING OF REACTOR EXPERIMENTS. Schneider, W. (Kernforschungsanlage, Juelich, Ger.). Atomwirt. Atomtech.; 17: No. 7, 359-61(Jul 1972). (In German).

In the Juelich reactor, irradiation experiments were performed in connection with the development of gas-cooled high-temperature reactors, development of structural steels for reactors, and development of incore-thermionic reactors. More than 5000 measurements were performed with respect to temporal and spatial distribution of neutron and gamma fluxes; changes of flux, temperature, and spectral distribution; and dose monitoring. Activation probes were used for neutron measurements. Four semi-automatic measuring devices were permanently installed for the determination of neutrons, β and γ radiation. The internal γ flux was measured with argon-filled miniature ionization chambers. Problems associated with the measurements and their solutions are presented. (H.B.G.)

4758 DISTRIBUTION OF GAMMA RADIATION EXPOSURE RATE IN THE UTR-B REACTOR ROOM AT 0.1 WATT OPERATION. Morishima, Hiroshige; Koga, Taeko; Honda, Yoshihide; Kawai, Hiroshi; Niwa, Takeo (Kinki Univ., Osaka). Kinki Daigaku Genshiryoku Kenkyusho Nenpo; 8: 17-22(1970). (In Japanese).

The distribution of γ radiation exposure rate in the UTR-B reactor room when the reactor was operated at 0.1 watt is reported. The following results were obtained: (1) The highest exposure rate was measured to be 2.2 mR/hr at the place of neutron source hole on the top closure of the reactor. (2) The iso-exposure rate map at the horizontal section was extended in the direction of south and north. The highest exposure rate on the surface of the side wall of the shield was measured to be 0.10 mR/hr. (3) The elevated exposure rate on the surface of the side wall of the shield during reactor operation was decreased to the background level in 4 to 6 minutes after shutdown of the reactor. (auth)

4759 REACTOR SPACE–TIME ANALYSIS AND EXPERIMENTS. Weaver, Gabriel Howard. Atlanta; Georgia Inst. of Tech. (1971). 160p. University Microfilms Order No. 72-19,713.

Thesis.

The flux in the Georgia Tech Research Reactor, a heavy-water moderated and cooled research reactor fueled with highly-enriched uranium, was sampled 100 times per second at several positions in the core and reflector as the reactor was shut down with a special control-rod-like device. Part of this hydraulically-operated device fit into the central fuel element position of the reactor and inserted a control rod at selected speeds. Two different rods were used, one of aluminum, worth approximately 1.5 percent $\Delta k/k$, and one of stainless steel, worth approximately 8 percent $\Delta k/k$. Two-dimensional, multi-group, cylindrical-geometry statics and associated kinetics models of the experiment were developed. These models varied the boundaries of the central regions axially to simulate the insertion of a control rod. A digital kinetics program based on this geometrical model and using a theta-weighting scheme to solve the spatially differenced (space-time) kinetics equations was developed. However, options in the kinetics program permitted any or all energy groups to be treated adiabatically. The results of ten different experiments are reported. Each of these experiments was simulated both with the kinetics code operating in the purely space-time mode and in the purely adiabatic mode. These kinetics simulations were in fair agreement with the experimental results. The differences between analysis and experiment were primarily due to the inability of the homogeneous statics model to accurately predict the static flux shapes and reactor multiplications of the heterogeneous reactor. The purely space-time calculations were compared to the adiabatic ones. Significant differences were apparent for rapid insertions; however, for slow insertions these differences diminished. Also, it was found that space-time calculations on the thermal group in conjunction with adiabatic calculations for the fast group led to results which were in agreement with the treatment of both groups by the space-time approximation. This suggests the attractive possibility of using mixed methods to perform multigroup, 2-D kinetics calculations with substantially improved economy. (Diss. Abstr. Int., B)

4760 SPLIT-TABLE CRITICAL FACILITIES FOR THE AUSTRALIAN AEC. McCulloch, D. (Australian Atomic Energy Commission Research Establishment, Lucas Heights); Naigeon, J. Nucl. Eng. Int.; 17: No. 195, 633-6(Aug 1972).

A split-table critical facility installed at Lucas Heights is suitable for a wide range of studies on reactor core configurations for all types of thermal reactors and for fast reactor cores up to the largest dilute commercial types. The main features of the facility, safety aspects, and the design and operation of the split-table machine are described. (UK)

4761 SODIUM TECHNOLOGY. Shannon, D. W.; Wykoff, W. R. (Hanford Works, Richland, Wash.). Nucl. Eng. Int.; 17: No. 195, 627-8(Aug 1972).

FFTF sodium technology programs are directed toward fuel failure monitoring, purity control and monitoring in sodium and cover gas, and evaluating and predicting the effects of the sodium environment on reactor materials. Each of these areas is briefly reviewed. (UK)

4762 INSTRUMENTATION AND CONTROL. Mitchell, J. W. (Hanford Works, Richland, Wash.); Heck, F. M. Nucl. Eng. Int.; 17: No. 195, 625-7(Aug 1972).

The FFTF is highly instrumented to meet safety, operational and test data needs. The plant employs conventional instrumentation and control systems, which are briefly described. (auth)

4763 SIMULATED BOILING EFFECTS IN A SUBCRITICAL ASSEMBLY. Lord, Robert John. Atlanta; Georgia Inst. of Tech. (1972). 139p. University Microfilms Order No. 72-20,605.

Thesis.

The objective of the research described was to predict and measure the effect of simulated boiling on the decay constants and associated lattice parameters of a heterogeneous light-water natural-uranium subcritical assembly. The ability to predict with accuracy the effect of voids on lattice parameters is vital in certain phases of safety analysis. In order to accomplish the experimental objective the subcritical assembly was pulsed with a neutron generator and the thermal die-away spectrum was measured and analyzed with respect to the decay constant for several bucklings. Two cases were considered: dynamic voids simulating boiling in hot channels such as might result from coolant flow stoppage or excess heat production, and the non-voided case. Voids of 40, 50, and 60 percent central moderator displacement, consisting of bubbles of compressed air introduced into the central region of the assembly, were used. The predictions were ob-

tained through the use of the nuclear analysis programs THERMOS, TEMPEST II, FORM, and EXTERMINATOR-2. The cross section programs TEMPEST II and FORM required input parameters describing a homogenized assembly. This standard method was used to obtain one set of cross sections representative of the assembly. A second set of cross sections, which took into account to a limited extent the heterogeneity of the assembly, was derived from these same two programs. A third set of cross sections utilized THERMOS, which does not require homogenized input. Three sets of lattice parameters and decay constants resulted from this study. Finally, the experimental decay constants were compared to the three sets of analytical decay constants. A large thermal neutron spectrum cooling appeared for both the voided and non-voided cases. After taking this into account reasonable agreement between experiment and heterogeneous predictions was achieved. (Diss. Abstr. Int., B)

4764 INTER-UNIVERSITY JOINT USE OF GOVERNMENT NUCLEAR FACILITIES IN JAPAN. I. Suita, T. (Osaka Univ.); Togo, Y.; Hasegawa, K. Nippon Genshiryoku Gakkaishi; 14: No. 10, 559-63(Oct 1972). (In Japanese).

Five cases of inter-university cooperative arrangements for use of government nuclear facilities in Japan are summarized. These can be classified in three categories: cooperative use of nuclear facilities of non-university government laboratories; joint university research institute; and cooperative use of university nuclear facilities. The first arrangement has been working effectively since 1961 when the Japan Atomic Energy Research Institute accepted a request to let universities use several research reactors and other facilities. The γ-field facility of the Ministry of Agriculture and Forestry also is now available for university research workers. The unique example of the second category is the Research Reactor Institute of Kyoto University. This institute was established in 1963 and it has a tank type research reactor (5 MW), an electron linac and other experimental facilities. A multi-purpose critical assembly is now under construction and plans are being made for a high flux research reactor. There are two examples of the third arrangement: the Fast Source Reactor of the University of Tokyo and the JMTR Radiation facility of the Tohoku University. Problems commonly faced by many of the above mentioned cooperative arrangements include the following: difficulties found by private and prefectual university research workers, and graduate students in joining these organizations; difficulties in the evaluation of research results obtained by cooperative research groups and from the use of common facilities; compatibility between the institute staff's own research program and that for utilization of the facilities for the cooperator; and inadequacy of funds and personnel for the cooperative programs. (auth)

4765 TOKAI REACTOR SIMULATOR (TRS). Kasai, M.; Ogawa, S. (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 14: No. 10, 549-58(Oct 1972). (In Japanese).

A small reactor simulator was constructed, utilizing an analog computer and the console of JRR-1. The simulator TRS (Tokai Reactor Simulator) is designed for reactor operation trainee experiment. With this simulator, experiments can be performed that aim at implanting a better understanding of the spatial dependency of the in-core neutron flux, including the case of critical approach and the measurement of neutron importance. The TRS is a wide-range kinetics simulator operative continuously from start up to full power. The simulator and some examples of experiments performed therewith are described. (auth)

4766 PRESENT STATUS AND FUTURE PLANS REGARDING THE DEVELOPMENT AND UTILIZATION OF PULSED REACTORS IN JAPAN. Nippon Genshiryoku Gakkaishi; 14: No. 7, 357-67(Jul 1972). (In Japanese).

The repetitively pulsed fast reactor and the one-shot thermal pulsed reactor are recognized in Japan to be the most useful future research reactors. The former calls for a carefully planned long-term program for its development, while the latter is already a proven type. A Linac Fast Booster has been adopted as the intermediate target to be aimed at in the present stage of development of the repetitively pulsed fast reactor. The specifications, preliminary design, progress in related research programs, and schedule for future developments are described. Important developments in thermal pulsed reactor field are also reported. 40 references. (auth)

4767 PELINDUNA CRITICAL EXPERIMENT. De Villiers, J. W. L. (Atomic Energy Board, Pelindaba, Pretoria). S. Afr. Mech. Eng.; 20: No. 10, 327-41(Oct 1970).

The PELINDUNA-Zero critical facility in the Atomic Energy Board's laboratories at Pelinduna is described. The first reactor system investigated in this facility is also described and an assessment of the hazards associated with the planned experiments is given. The core of the first system consisted of 4 elements of the PELINDUNA design, loaded to a maximum height of 2.1 m with 1 cm-dia uranium metal spheres enriched to 2% in ^{235}U. These elements were arranged in a square lattice pattern in heavy water inside a 1.6 m-dia tank. Four control rods are provided. A 20 cm-dia valve serves as an additional safety device. Although the PELINDUNA system is a heavy water moderated, sodium-cooled reactor, no sodium is allowed in the critical facility. This ensures a negative temperature coefficient, due mainly to the doppler effect in the fuel. The design, construction and safety instrumentation for the critical assembly conform to general practice in the operation of critical assemblies. The reactor is completely self-limiting for a 51 excess reactivity step with no hazard to the general public. This will probably also apply for a 52 step, while the public hazard remains extremely small. (INIS)

4768 MEASUREMENTS OF k-INFINITY ON ZERO-LEAKAGE ZONED SYSTEM (FCA IV). Nakano, Masafumi (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 7, 395-405(Jul 1972).

The infinite multiplication factor k_∞ of the test zone composition was measured for a series of FCA IV assemblies with a central test zone composed to produce a k_∞ value close to unity. For the experimental determination of k_∞, in which some calculations as well as the reactivity worths of the cell and standard sample measured at the center are necessary, a new method of analysis is presented and is compared with the current method. The new method provides the theoretical basis for k_∞-experiments. It also simplifies the calculations for analysis. The FCA IV comprises a series of three assemblies of different test zone compositions representing pure uranium, uranium-sodium and uranium-graphite systems, all of which contain a portion of structural stainless steel. From the analyses made with different cross section sets, it was confirmed that the experimental value of k_∞ could be obtained with an accuracy of ±0.01, and in certain cases, ±0.005, for a zoned system with a central test zone with diameter larger than fifteen times the mean free path. 12 references. (auth)

4769 TIME-OF-FLIGHT NEUTRON SPECTRUM MEASUREMENTS IN A BEAM FROM HORIZONTAL CHANNELS OF HEAVY WATER AND AN SM-2 REACTOR. Kalebin, S. M.; Adib, M.; Rukolaine, G. V.; (and others). At. Energ. (USSR); 32: No. 6, 485-7(Jun 1972). (In Russian).

Measurements of the horizontal neutron beams in the research reactor SM-2 were compared with those in a thermal, heavy water reactor. A neutron chopper was employed at horizontal channels in both cases. The experimental spectra of neutrons at stated temperatures are compared with the spectra obtained from calculations. (K.S.W.)

4770 OPTIMIZATION OF FUEL DISTRIBUTION IN A PHYSICAL RESEARCH REACTOR. Zaritskaya, T. S.; Petrov, Yu. V.; Rudik, A. P.; Sakhnovskii, Z. G. At. Energ. (USSR); 32: No. 6, 490-1(Jun 1972). (In Russian).

Functions are presented and discussed which attempt to estimate a reactor's fuel consumption in terms of variables such as reactor power, fuel burnup, thermal neutron flux, reflector parameters, etc. It is shown that for each reactor with known constants of the active zone and reflector, three values of reactor power may be postulated, and for each power level there exists its optimum fuel arrangement. (K.S.W.)

4771 EXPERIMENTAL AND THEORETICAL STUDY OF THE SOURCE-SINK METHOD AS APPLIED TO A SUBCRITICAL, NATURAL URANIUM, HEAVY WATER LATTICE WITH CONTAINED ABSORBERS. Zadworski, Zenon Francis. Toronto; Univ. of Toronto (1971). National Library of Canada, Ottawa. Thesis.

Neutron fine-structure measurements on five different configurations of absorbing pencils, as well as reference-lattice measurements, were carried out in the University of Toronto natural uranium, heavy water, sub-critical reactor. The whole sub-critical system, consisting of cylindrical fuel bundles in heavy water as a moderator (D_2O) (sources and sinks) cylindrical cobalt pencils in D_2O (sinks) fed with two external neutron sources (point sources), the first one in D_2O and the second one in graphite under the reactor vessel, was a difficult system with regard to neutron-flux calculation and the measurements provided a valuable source of information for checking theory, especially the calculations of flux-depression around the pencils (fine-structure calculations) in the system in which they were measured. As a first approach to the problem, neutron transport theory was tried, but gave unsatisfactory results because an acceptable approximate form of it is very hard to adapt to

the present system, so that further calculations were carried out using the source-sink method. However, because of the complexity of the University of Toronto sub-critical system the source-sink theory could not be applied in its existing form, and an extensive study of the subject was necessary. This study led to some theoretical concepts and ideas. On the basis of the source-sink method, a "leak-out" term for a finite system was derived permitting the mathematical treatment of each system as an infinite one, and reducing the restrictions imposed by finite geometry. Also, by means of the source-sink formulation a method of breakdown of a point-source into a plane and a line-source was developed. It made possible the mathematical treatment of both line and point-sources in the same way. Further, on the basis of the source-sink equation a useful solution of the differential equation for a point-source system in two different media, including the interface effect between them, was obtained. Finally, in those situations in which the strict source-sink formalism could be used, another method of evaluating the "thermal constant" through the blackness of a lump or mass of fuel was developed. All concepts showed good agreement with experiment when employed in the source-sink calculations of the present study. The experimental work was essentially a study of the neutron-flux depression around the absorbing pencils substituted into the reactor, as the number of pencils increased from 0 to 5. The measurements of the neutron densities were carried out across the absorbers and in the moderator between them, with special care in their vicinity. Special attention was given to the accuracy of the measured points, and for this reason all necessary precautions were undertaken during the measurements. (Diss. Abstr. Int., B)

4772 IN-CORE EDDY CURRENT MEASUREMENTS OF ATR FUEL ELEMENT CHANNEL SPACING. **Prestridge, F. L.; Stanley, M. L. (Idaho Nuclear Corp., Idaho Falls). Mater. Eval.; 30: No. 10, 214-18; 28(Oct 1972).**

A nondestructive testing technique was adapted and used successfully to make a difficult applied measurement under the restrictions of small space, thermal gradients, a radioactive environment, and underwater. During Core I tests, or first power tests of the Advanced Test Reactor at the National Reactor Testing Station, Idaho Falls, Idaho, it was necessary to measure the coolant-channel thickness spacing in selected fuel elements. These measurements had to be made "in-core" with standby coolant water flowing while the elements were still giving off a considerable amount of decay heat. These requirements imposed the following restrictions on the measuring transducer: It had to be small enough to be inserted in a channel as small as 0.055 in. thick with a range up to 0.120 in., good resolution, low radiation sensitivity, output independent of temperature, and high repeatability. The transducer chosen was an eddy current type using phase demodulation techniques to separate unwanted signals. The technique has proven itself in field application and opened the way for future use of this type transducer in many severe environments. (auth)

4773 FAST NEUTRON SOURCE REACTOR "YAYOI" IN UNIVERSITY OF TOKYO. Wakabayashi, H. (Tokyo Univ.). FAPIG (Tokyo); No. 64, 210-21 (Feb 1972). (In Japanese).

"Yayoi" is a fast neutron source reactor which has reached its criticality on April 10, 1971 at the atomic energy research establishment in University of Tokyo. It has a maximum thermal energy of 2 kW, a maximum neutron flux of 10^{12} neutrons/cm^2 · sec. It is composed of the 93% enriched uranium of 28 kg, 0.4% uranium blanket, lead reflector and air coolant and etc. This reactor design was based on the Argonne Fast Source Reactor, HARMONIE in France, and TAPIRO in Italy. This reactor is used for basic and applied studies of fast, intermediate, and thermal neutrons, and research on the stability of equipments associated with fast reactors. Its reactor core can be moved horizontally back and forth on a flatcar so as to make operation at various positions possible. This reactor can duplicate the performance of several reactors, that is, the neutron field generated by this reactor has the characteristics of the standard neutron field. Multiple experiments can be performed with the least mutual interference and at a high rate of operation. Various characteristics tests have been performed. The power up test is scheduled in 1972. And "Yayoi" is also scheduled to be operated as "A pulse reactor." (Tai, I.) (Japan)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 2489, 2863, 2865, 2866, 2872–2874, 2960, and 2964.

4774 (AEC-tr-7386) PROBLEMS OF EXPLOSIONS INSIDE CONTAINMENT VESSELS. Translation of a French paper. 23p. Dep. NTIS.

Some elementary notions about explosions and pressure waves are presented for the purpose of identifying the simpler tests to be performed for finding elementary laws of explosion containment. For production, propagation, and containment of pressure waves, it appears necessary to conduct simulation tests at various scales. Low-pressure explosions with gas mixtures appear useful for simulating nuclear.core explosions. Some unpublished CEA results on structural behavior under explosion are summarized. A correlation law is given for published American results on open tubes. The appendices include information on: known models and laws of propagation; a calculation of the motion of a wall subjected to a plane acoustic wave, with or without cavitation; and the results of testing small explosions in tubes and a correlation with theory. (auth)

4775 (KFK-1520) PREPARATION, RADIATION, AND OBSERVATIONS OF THE MOL 8A IRRADIATION EXPERIMENTS. **Herrmann, H.; Hoffmann, H.; Geithoff, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Material und Festkoerperforschung). Jun 1972. 70p. (In German). Dep. NTIS (U. S. Sales Only).**

The irradiation experiment Mol 8A consisted of the irradiation of 2 pins in the BR 2 reactor. All thermal neutrons were absorbed with a Cd-screen in order to produce a fast neutron irradiation. The pins consisted of $(U,Pu)O_2$-pellets clad with austenitic steel. The burnup of 50,000 MWd/t heavy atoms was reached with a rod power of 400–500 W/cm and a cladding surface temperature of maximum 650°C. The aim of the experiments, the pin design, the construction and specification of the pins, the preparation of the specimens, the irradiation history and the whole postirradiation examination are reported. (12 references) (auth)

4776 SHUTTING-OFF DEVICE FOR NUCLEAR REACTOR. Barrau, Pierre; Boulot, Francais; Margueron, Jean; Pages, Pierre (to Societe pour l'Industrie Atomique). French Patent 2,104,922. 28 Apr 1972. Filed 4 Sep 1970. (In French).

A shutting-off device for dividing the vessel of a nuclear reactor into a compartment which houses the core and in which a fluid coolant flows and another compartment in which the pressure is lower is presented. This device consists of a shutting-off lid which operates in conjunction with a seating provided on the vessel by two coaxial supports separated by an intermediate chamber. The system is provided with a means for connecting this chamber to the cooling fluid above the core. (France)

4777 IMPROVEMENTS IN DETECTING BURST SLUGS IN NUCLEAR FUEL ELEMENTS. Donguy, Rene; Graftieaux, Jean; Riquois, Guy (to Commissariat a l'Energie Atomique). French Patent 2,101,109. 31 Mar 1972. Filed 24 Aug 1970. (In French).

A device for simultaneously ensuring the overall surveillance of a reactor installation and locating the region in the core of the reactor in which the fission products of a burst slug are escaping is described. (France)

4778 SEALED DEVICE FOR MOUNTING HEAT EXCHANGERS IN REACTORS. Vercasson, Michel (to Commissariat a l'Energie Atomique). French Patent 2,101,019. 31 Mar 1972. Filed 7 Aug 1970. (In French).

A device for the sealed mounting of the body of an exchanger in an opening in the wall of the primary vessel of a reactor is described. The primary vessel of the reactor is immersed in a liquid metal such as Na, which acts as the cooling fluid. The opening is provided with a vertical cylindrical skirting covered with an annular cover fixed to the body of the exchanger; this cover is arranged in such a way that with the skirting an annular siphon is formed. This siphon is maintained uninitiated by injecting pressurized gas into its upper part. (France)

4779 SHOCK DAMPER. Moutier, Michel; Naudet, Robert (to Commissariat a l'Energie Atomique). French Patent 2,102,539. 7 Apr 1972. Filed 7 Aug 1970. (In French).

A shock absorber device that ensures the deceleration and final stopping of a falling mass is presented. The device is used as a parachute to stop free falling of the control rods without damaging the thrust blocks of the reactor structure. It consists of several elements which function together elastically and absorb the kinetic energy of the moving mass. One of the elements can be elastically compressed until a maximum position is reached whence the elongation of another part absorbing the remaining kinetic energy is initiated. This other part undergoes a permanent deformation. (France)

4780 TWO-PLUG FUEL HANDLING SYSTEM FOR A NUCLEAR REACTOR. Marmonier, Pierre; Sauvage, Michel (to

Commissariat a l'Energie Atomique). French Patent 2,101,062. 31 Mar 1972. Filed 14 Aug 1970. (In French).

A system for handling the fuel elements of fast neutron reactors is described. It consists of a large plug which turns with respect to the wall of the reactor and a small plug which rotates eccentrically with respect to the large plug. This small plug is provided with at least one channel for handling the fuel elements. The control rod drives are distributed inside the two plugs. Part of the core lid, which is fixed to the two plugs, is incorporated into the system. The positioning of the control rod drives in the two plugs enables the size of the small plug to be reduced and (possibly) the free space normally provided around the core necessary for the movement of the control rod drives when the plugs are rotated to be eliminated. (France)

4781 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Webb, John; Baddley, Albert Harold (to United Kingdom Atomic Energy Authority). British Patent 1,280,636. 5 Jul 1972. Filed 11 Nov 1968.

Reference is made to equipment for reactor shut-down. A severe power excursion may damage the reactor core to an extent that would prevent any of the normal control rods from being inserted, although in designing reactors steps are taken to minimize this risk. In some cases it has been thought necessary to provide shut-down equipment that operates on principles different from the usual systems and designed to operate effectively even if severe core distortion has occurred, for example ball shut-down devices. Another difficulty arises in that the provision of control and shut-down devices is made more complicated where a reactor has a rotatable refuelling shield above or below the core; alignment problems then arise. Additional shut-down equipment is described that overcomes these difficulties. This equipment comprises a rigid tube penetrating the reactor core, with one end projecting from the core, and a flexible shut-down absorber element freely mounted in the tube and normally located in the projecting end region. Servo means are provided for moving the element in the tube, with releasable means for retaining the element in the inserted position. The servo means may consist of a liquid-filled cylinder and pipework, the liquid being the same as, or compatible with, the reactor coolant, and the releasable means may consist of a remote controlled latch mounted in the tube. (UK)

4782 NUCLEAR REACTORS. Ebeling, Douglas Roy; Uebel, Royde Murray (to United Kingdom Atomic Energy Authority). British Patent 1,280,532. 5 Jul 1972. Filed 26 Feb 1969.

Reference is made to reactors of the type wherein nuclear fuel is housed in groups of parallel tubes extending vertically through the reactor core and steam is generated from water coolant flowing through the tubes. In such a reactor each tube inlet normally has a variable fluid flow restricting means, responsive to a reactor signal, and the tubes are arranged in groups with all the restriction means of a group variable in the same sense by the same signal. The fluid flow restricting means takes the form of a multiple outlet port valve for each group of tubes, with each outlet port connected to a tube inlet. With this system it is thought that at low power and low rates of coolant flow the pressure drops across the variable restrictions of the multiple outlet port valve will require such small orifices that they may be susceptible to blockage and also result in such high flow velocities that severe erosion may occur. The object of the system described is to lessen the risk of blockage and erosion. In this system each tube inlet has an individual variable fluid flow restricting means and a common inlet to a group of tubes has variable fluid flow control means responsive to a reactor signal. The restriction means serve to reduce hydrodynamic instabilities between tubes, and the fluid flow means serves to control the coolant flow, so that full pressure drop takes place over both means. The orifices of the restriction means are larger even at low power, so that flow velocities and erosion are reduced. (UK)

4783 SCOT: DEVELOPMENT OF A RIG FOR THE OUT-OF-PILE TESTING OF REACTOR FUEL ELEMENTS AND COMPONENTS. Etherington, C.; Jones, C. H. (United Kingdom Atomic Energy Authority, Springfields, Eng.). J. Brit. Nucl. Energy Soc.; 11: No. 3, 291-7(Jul 1972).

The UKAEA CO_2 loop at Springfields, known as the SCOT loop, is described and its development is traced from a loop for testing uranium magnox fuel to one for testing the latest CAGR fuel stringers and components. The major loop components and current work are described. (auth)

4784 NUCLEAR REACTOR INSTALLATIONS. Emerson, David Colin (to United Kingdom Atomic Energy Authority). British Patent 1,278,270. 21 Jun 1972. Filed 13 Nov 1969.

Reference is made to reactor fueling machines. In machines such as that employed for the Winfrith steam generating heavy water reactor the fine alignment is supervised by optical equipment; this equipment is complex and time consuming in operation, making fuel replacement a relatively long operation. The machine described enables the necessary operations to be accurately and easily carried out without the use of complex apparatus, rendering fueling operations simpler and less time consuming. The machine is supported on a hydrostatic bearing and is horizontally movable to a position where its telescopic nose is in approximate alignment with a selected vertical fuel element channel. The nose and the mouth of the fuel element channel have complementary sealing surfaces of shape such that, on being urged together, the machine is horizontally displaceable on its hydrostatic bearing into accurate alignment by the reaction forces of the nose and channel. Since bending moments applied to the nose are small, a simple gland can be used to seal together its telescopic portions, and flexible bellows are not required. The means for urging the nose into engagement with the mouth of the fuel element channel may conveniently be a hydraulic ram. The hydrostatic bearing comprises one or more pressurized oil films. (UK)

4785 EFFECT OF SURFACE ROUGHNESS OF A ROD FUEL ELEMENT ON HEAT TRANSFER. Vinogradov, O. S.; Puchkov, P. I. At. Energ. (USSR); 33: No. 3, 741-5(Sep 1972). (In Russian).

The results of experimental investigations of heat transfer and the resistance of rod fuel elements having smooth and rough heat-transfer surfaces are presented. It was shown that it is possible to significantly increase (~80%) heat transfer by providing surface roughness of relatively small dimensions. (auth)

4786 LEVEL DETECTING DEVICE UTILIZING THE HALL EFFECT. Marquet, Guy (to Commissariat a l'Energie Atomique). French Patent 2,096,693. 25 Feb 1972. Filed 10 Jun 1970. (In French).

A device which utilizes the Hall effect to detect the level of liquid in a reservoir constructed of magnetic material is described. The device is designed to measure the level of liquid CO_2 in a reactor loop. A float is provided inside the reservoir. This float carries a magnet which produces an intense configuration of lines of force at the free surface of the liquid. A number of magnetoresistive probes are placed at predetermined levels outside this reservoir. Each probe is connected to an electronic circuit. When the float passes a particular probe, the Hall effect causes its resistance to change. This change in resistance triggers its electronic circuit, which in turn actuates a relay which controls a corresponding illuminated marker. (France)

Reactor Physics and Core Engineering

Physics

Refer also to abstracts 2557 and 4759.

4787 (Y-CDC-11 (pp 1-18)) THE S_n METHOD. Lathrop, K. D. (Los Alamos Scientific Lab., N. Mex). 1 Sep 1972. 18p. Dept. NTIS.

The method of discrete ordinates (the S_n method) for numerical solution of the general transport equation is explained as simply as possible. The advantages and disadvantages of the method are discussed. Reasons are given for the complexity of programs which apply a basically simple method. Capabilities of such programs are briefly described, and guides to their usage are suggested. (auth)

4788 (Y-CDC-11 (pp 19-30)) MONTE CARLO METHOD AS APPLIED TO NUCLEAR CRITICALITY SAFETY CALCULATIONS. Whitesides, G. E. (Oak Ridge National Lab., Tenn.). 1 Sep 1972. 12p. Dep. NTIS.

The use of the Monte Carlo method to nuclear criticality is discussed in detail. Advantages of this method over other calculation methods are discussed. (8 references) (J.M.J.)

4789 CONCEPT OF ENERGY-DEPENDENT BUCKLING IN MULTI-GROUP DIFFUSION THEORY. 2. Beynon, T. D. (Univ. of Birmingham, Eng.). J. Nucl. Energy; 26: No. 10, 493-506(Oct 1972).

An analysis for energy-dependent buckling in multi-group diffusion theory is applied to water, natural iron, and beryllium. Computations are made in one- and two-dimensional space for the slowing down and thermalization processes. Comparisons made with exact numerical solutions show that the energy-dependent analysis gives better predictions for the total flux, absorption and leakage than a conventional constant-buckling approach. It is demonstrated that the best choice of constant buckling is not necessarily the one associated with the mean energy of the thermal energy spectrum. (auth)

4790 STABILITY ANALYSIS OF NONLINEAR POINT REACTOR KINETICS. Londen, Stig-Olof (Helsinki Univ. of Tech., Otaniemi, Finland). Advan. Nucl. Sci. Technol.; 6: 45-63(1972).

The present state of knowledge concerning qualitative results on the behavior of solutions of nonlinear point kinetics equations with linear feedback is reviewed. The emphasis is on providing general equation formulation only. 32 references. (H.D.R.)

4791 NEW DEVELOPMENTS IN POWER REACTOR CORE DESIGN. Johnson, R. D. (Atomic Energy Research Inst., Seoul). J. Korean Nucl. Soc.; 4: No. 2, 137-50(Jun 1972).

Three recently introduced techniques in the area of nuclear analysis are discussed: the structure-factor method of evaluating group material properties, the vector-synthesis method of generating three-dimensional multigroup flux distributions, and an indirect method of defining optimal restricted partitions of neutron phase-space. Each new method is compared with other commonly employed techniques and is shown to be a simplification which leads to a reduction in computational effort while retaining acceptable accuracy. 20 references. (auth)

4792 CLOSED-FORM ANALYSIS FOR SPACE DEPENDENT NUCLEAR REACTOR TRANSIENTS. Garland, W. J.; Harms, A. A. (McMaster Univ., Hamilton, Ont.). J. Nucl. Energy; 26: No. 9, 461-8(Sep 1972).

Closed-form solutions for the space and time dependent scalar flux and temperature distribution in multiplying media are presented. Correlations with existing solutions are identified and new functional relationships are established. In a numerical test it is found that the results obtained using the closed-form solutions are in excellent agreement with alternative finite difference formulations. (auth)

4793 STOCHASTIC TWO-GROUP MODEL FOR NUCLEAR REACTORS INCLUDING NEUTRON AND GAMMA DETECTION. Baers, B. (Univ. of Technology, Helsinki). J. Nucl. Energy; 26: No. 9, 445-60(Sep 1972).

Relaxation effects associated with the spontaneous fluctuations in the neutron population and in the photon emission in nuclear reactors are studied using a space-independent two-energy-group reactor and detector model. The approach is based on the forward Kolmogorov equation. The influence of a large number of reactor and detector characteristics on the variance of the cumulative number of signal units, on correlation functions and on power spectra is explicitly given. The influence of gamma radiation on noise measurements with gamma compensated ionization chambers is considered. Other detector types are obtained as special cases of the compensated ionization chamber. The treatment includes detection of photons, fast neutrons and thermal neutrons, and also absorption, recoil and fission type detectors. From the results obtained it is suggested that instead of, or in addition to, the fast neutron detectors previously proposed the more easily realizable photon detectors should be utilized to extract information on the fast group of neutrons in nuclear reactor systems. The use of noise measurement techniques for relaxation measurements in non-multiplying media is also suggested. (auth)

4794 DIRECT INTEGRAL FORMULATION OF POINT REACTOR KINETICS. Pettus, W. G.; Snioow, N. L. (Babcock and Wilcox Co., Lynchburg, Va.). J. Nucl. Energy; 26: No. 9, 489-90(Sep 1972).

Neutron kinetic equations are dealt with by formulating an integral neutron balance directly from physical considerations. The most general expression obtained is a double integral representation in which both the multiplication factor and the neutron lifetime are variable. Some simplifications, useful in practical applications, are pointed out. (UK)

4795 THERMAL NEUTRON TRANSPORT NEAR A MODERATOR DISCONTINUITY USING THE METHOD OF WEIGHTED RESIDUALS. I. THEORY. Beynon, T. D.; Moon, J. R. (Univ. of Birmingham, Eng.). J. Phys., D (London); 5: No. 5, 931-49 (May 1972).

The method of weighted residuals is used to produce approximate solutions to the integral form of the Boltzmann transport equation for thermal neutron fluxes near a moderator temperature discontinuity. Both spherical and plane geometries are considered. The validity of the technique is established by using a synthetic scattering kernal and making comparisons with exact transport theory solutions for two-temperature problems. The relative accuracy and importance of the choice of different weighting functions and of the number of trial modes in the flux expansion is investigated. Generally, it is found that using three or more Maxwellian distributions for the energy trial modes of the flux produces a significant increase in the accuracy compared with a diffusion theory approximation. (auth)

4796 ASYMPTOTIC REACTOR STABILITY WITH A THERMOEMISSION CONVERTER. Gorbunov, V. P.; Isaev, N. V.; Komarov, O. V.; (and others). At. Energ. (USSR); 32: No. 6, 501-3 (Jun 1972). (In Russian).

The dynamics and stability of a reactor wherein a thermoemission converter is located in the active zone are described by appropriate equations. It proved possible to formulate criteria of suitable conditions of asymptotic stability for a nonlinear model of a reactor of this type. (K.S.W.)

4797 DETERMINATION OF MIGRATION AREA. Sergeev, I. V.; Platovskikh, Y. A. At. Energ. (USSR); 33: No. 1, 580 (Jul 1972). (In Russian).

Commonly, the determination of migration area $M^2 = L^2 + \tau$ may be used for finding k_{eff} of a reactor without a reflector in the case where fission occurs only in the thermal region. A suggestion is made for determining the migration area in a subthermal region in the presence of fission, starting with a statistical equation involving neutron density, scattering, and diffusion functions. (K.S.W.)

4798 KINETIC PARAMETERS FOR SUBCRITICAL ASSEMBLIES. Kolosov, B. I.; Matveenko, I. P.; Pupko, V. Ya.; (and others). At. Energ. (USSR); 33: No. 1, 579-80(Jul 1972). (In Russian).

The use of small samples for studying effects in breeder systems permits the use of first order perturbation theory. Measurements are generally conducted in reactors near the critical state, and the measurements of perturbation of the system serve as changes in its reactivity. The latter is very difficult in distinctly subcritical systems; for these a fundamental quantity characterizing system perturbation and experimentally measurable is the change in the asymptotic decrement of attenuation α for prompt neutrons. Such a decrement is evaluated by the pulsed neutron source method. For the experimental work absorbers were fabricated from a mixture of Al_2O_3 and boron carbide which should correspond to fuel composition, and used to replace a fuel element. Kinetic parameters Λ, l, and α/α_{crit} were measured as functions of k_{eff}; calculated values agreed very well. (K.S.W.)

4799 INTERPRETATION OF DYNAMIC EXPERIMENTS IN THE DETERMINATION OF REACTIVITY. Shishin, B. P. At. Energ. (USSR); 33: No. 1, 582-4(Jul 1972). (In Russian).

Interpretation of experiments in reactivity measurement was refined, making allowance for peculiarities in the experiments, properties, and disposition of the detector. Three sets of formulas are offered in outline form for the determination of reactivity: the "multiplication" method, the "rod drop" and "oscillating source" methods, and the "pulsed source" method. A discussion of these three methods and their operational formulas are presented. (K.S.W.)

4800 SPACE- AND ENERGY-DEPENDENT NOISE ANALYSIS USING MODAL EXPANSIONS. Ebert, David Dean. Atlanta; Georgia Inst. of Tech. (1972). 218p. University Microfilms Order No. 72-20,601.

Thesis.

Space- and energy-dependent neutron noise analysis, which falls within the field of reactor kinetics, is examined. The objective of the investigation was fourfold: 1. to indicate the interrelation between time- and frequency-domain noise techniques; 2. to demonstrate how modal approximations of the neutron noise follow from the manner in which the Green's function or transfer matrix is approximated; 3. to derive an exact solution and several modal approximations of the coherence function in one-dimensional coupled core reactor models, and investigate their characteristics with changing core and detector conditions; 4. to postulate and utilize methods by which some important dynamic reactor parameters can be inferred from the measured coherence function or modified coefficient of correlation in zero-power coupled core reactors. (Diss. Abstr. Int., B)

4801 SHIELDING FACTOR METHOD OF GENERATING MULTIGROUP CROSS SECTIONS FOR FAST REACTOR ANALYSIS. Kidman, R. B.; Schenter, R. E.; Hardie, R. W.; Little, W. W. (Westinghouse Hanford Co., Richland, Wash.). Nucl. Sci. Eng.; 48: No. 2, 189-201(Jun 1972).

The essential features of the shielding factor method of computing effective multigroup cross sections are presented. This includes both the generation of shielding factors and infinitely dilute cross sections from the ENDF/B data, and the use of these constants in computing effective multigroup cross sections. Representative numerical results comparing the shielding factor method with another, more detailed, cross-section generation technique are also included. (13 references) (auth)

4802 REACTOR PARAMETERS FROM NEUTRON AND GAMMA-RAY NOISE MEASUREMENTS. Baers, Bruno; Markkanen, Esko (Helsinki Univ. of Tech., Otaniemi, Finland). Nucl. Sci. Eng.; 48: No. 2, 202-10(Jun 1972).

Rossi-alpha auto- and cross-correlation measurements on a large subcritical assembly using an in-core neutron detector and in-core and ex-core photon detectors are reported. The correlation amplitude and the main relaxation constant were determined in each measurement. The relaxation constants ($\bar{\alpha}$ = 4090 1/sec) and the nine relative correlation amplitudes obtained were used to determine four space damping factors and some basic parameters describing the sources of correlated fluctuations. By utilizing some basic fission parameters ($\langle\nu\rangle$, $\langle\nu^2\rangle$, spontaneous fission probability) and the effective multiplication factor (k = 0.788) from pulsed-neutron source measurements or from computations, estimates for the prompt-neutron lifetime (l = 53.2 μsec), the equivalent number of free neutrons ($\langle y_0\rangle$ = 5.24) in the reactor, the mean fission rate ($\alpha_f\langle y_0\rangle$ = 73 800 1/sec) and the efficiency (ϵ_nl = 8.1 × 10^{-4}) of the neutron detector could further be determined. The results verify the applicability of the gamma observation technique in reactor noise measurements as a substitute and a complement to noise measurements via neutron detector. (14 references) (auth)

4803 OPTIMIZATION OF IMPORTANCE-SAMPLING PARAMETERS IN MONTE CARLO. MacMillan, D. B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Contract W-31-109-Eng-52. Nucl. Sci. Eng.; 48: No. 2, 219(Jun 1972).

Let α be a parameter governing a Monte Carlo importance sampling process. Formulas are given by which the results of a Monte Carlo run may be used to estimate the derivatives of the variance with respect to α. It is pointed out that these derivatives may be used to optimize α, that is, to minimize the variance of the Monte Carlo problem. (auth)

4804 ERROR ESTIMATION OF EIGENVALUES IN REACTOR THEORY PROBLEMS. Ronen, Yigal (Atomic Energy Commission Nuclear Research Centre-Negev, Beer-Sheva, Israel). Atomkernenergie; 19: No. 4, 281-2(Jul 1972).

An analytic method which enables determination of the order of magnitude of a change in the eigenvalues of a homogeneous equation due to a change in the operator is presented. The method is not limited to a certain type of operator. (auth)

4805 IMPROVED PRACTICAL WIDTH FOR IR CALCULATIONS. Elmeshad, Y.; Ibrahim, Eleraky (Alexandria Univ., Egypt). Atomkernenergie; 19: No. 4, 295-7(Jul 1972).

A method is proposed for calculating the intermediate parameters for an isolated resonance of a resonance absorber in an absorber-moderator homogeneous mixture. The method is based on Forti's physical approach but it takes into consideration the variation of the intermediate character of the resonance due to the presence of the moderator. By imposing the requirement that the physical intermediate parameters should be approximately the same as those used in the nonlinear mathematical approach, an expression for the proper practical width is analytically deduced. (9 references) (auth)

4806 IR TREATMENT OF HETEROGENEOUS LATTICES BY A MODIFIED μ-METHOD. Elmeshad, Y.; Ibrahim, Eleraky (Alexandria Univ., Egypt). Atomkernenergie; 19: No. 4, 298-300(Jul 1972).

The resonance integral for single isolated resonances is evaluated in heterogeneous systems. The intermediate characters of the resonance with respect to absorber, moderator and admixed moderator are taken into consideration. The intermediate character with respect to absorber is treated by the μ-method; and is combined to the π-width concept to account for the intermediate character with respect to moderator and admixed moderator. The ^{238}U 6.7 eV, 189.6 eV and 237.5 eV resonances are treated as examples in lattices with ^{1}H, ^{9}Be, ^{12}C and ^{56}Fe as moderators. Both ^{238}U and $^{238}UO_2$ are considered as absorbers. The value of resultant resonance integrals are compared to those obtained by the nonlinear mathematical approach. (auth)

4807 DEVELOPMENT AND COMPUTATIONAL MERITS OF A TRANSPORT CONSISTENT DIFFUSION THEORY. Sullivan, Lester Harold. College Park, Md.; Univ. of Maryland (1971). 135p. University Microfilms Order No. 72-18,904.

Thesis.

A transport consistent multi-group diffusion equation was derived from the conservation equation by developing a transport theory Fick's law. To obtain the transport theory form of Fick's law, the Boltzmann transport equation is multiplied by the $\hat{\Omega}$ vector and integrated over all $\hat{\Omega}$ and an arbitrary speed group. To allow each direction to be analyzed independently, the $\hat{\Omega}$ vector is written using an arbitrary set of direction vectors for an orthogonal coordinate system. By expanding the scattering function in spherical harmonics and writing the three components of the $\hat{\Omega}$ vector in spherical harmonics, the integration over the $\hat{\Omega}$ variable can be performed. The resulting equation is a transport theory consistent Fick's law. The assumptions used to reduce the transport Fick's law to a form which has an appearance similar to the general Fick's law are: 1. no time dependence; 2. isotropic external and fission sources; 3. separation of variables for the speed and angular dependences for a energy group. With the above assumptions a transport Fick's law is obtained in which the diffusion coefficient is a function of the space variable. The diffusion coefficient is not a simple constant, but a 3 × 3 matrix, dependent on the angular flux, current, and cross sections. Using an approximative formulation for the space angle dependent flux density, a spatially dependent diffusion coefficient can be obtained. A multi-energy group diffusion equation is obtained from the conservation equation by substituting the transport Fick's law equation in the leakage term. The resulting diffusion equation is consistent with transport theory. To obtain better flux profiles, the spatially dependent diffusion coefficient can be used in existing diffusion codes with only slight modifications. The spatially dependent diffusion coefficient generated from angular fluxes from a transport theory code were investigated for several different configurations and materials. It was found that the diffusion coefficient was spatially dependent, and was different from the usual value of $\lambda_{tr}/3$ for several materials. The use of spatially dependent diffusion coefficients in a diffusion theory program (1DX) improved the flux calculation both in magnitude and shape. (Diss. Abstr. Int., B)

4808 RECONSTRUCTION OF NEUTRON SPATIAL DISTRIBUTION FROM SPATIAL MOMENTS. Soran, Patrick Dennis. New York; Columbia Univ. (1971). 139p. University Microfilms Order No. 72-19,163.

Thesis.

Although the moments method for solving neutron transport problems has been standard in the field for more than fifteen years, the problem of reconstructing the spatial flux from the moments still remains a formidable task. Only a finite number of spatial moments are available from which a spatial reconstruction of the flux can be performed. The problem has no unique solution. An infinite class of spatial functions can exactly reproduce the same set of moments. Traditional approaches, employing such techniques as fitting the moments with a sum of several functions of similar form (i.e., "function fitting") or biorthonormal polynomials have been found inadequate in many respects. As previously applied, these methods fail in instances when the fitting functions and the actual flux are too dissimilar. An effort is made to overcome these difficulties by applying a new approach and newer techniques to solve the problem. Classes of functions are chosen on the basis of physical plausibility, thus the intent is to solve a physical rather than a purely mathematical problem. As part of this approach, a general method of analysis was developed whereby qualitative information is gleaned directly from the moments before reconstruction is attempted. The general shape of the neutron spatial distribution is deduced from the behavior of the ratios of successive even order moments as a function of increasing order (i.e., signature curves). Such a procedure enables one to best determine what type of function or class of functions should be implemented in an actual reconstruction of the flux. (Diss. Abstr. Int., B)

4809 VARIATIONAL ESTIMATES OF REACTIVITY WORTHS AND REACTION RATE RATIOS IN CRITICAL NUCLEAR REACTORS. Stacey, Weston M. Jr. (Argonne National Lab., Ill.). Nucl. Sci. Eng.; 48: No. 4, 444-58(Aug 1972).

A variational theory is developed for estimating reactivity worths (and other bilinear ratios) and reaction rate ratios in critical nuclear reactors. These estimates embody corrections to first-order perturbation theory which account for the flux change caused by the reactivity perturbation and for the changes in the flux and adjoint when the system is altered. The physical significance of certain generalized functions which arise in the development of the theory is investigated. The relation of the variational theory to generalized perturbation theory is examined, and the additional restrictions required to reduce the former to the latter are established. Finally, the variational theory is demonstrated to yield accurate estimates for reactivity worths and reaction rate ratios in a fast reactor model, subject to a wide range of alterations in nuclear properties and compositions. 12 references. (auth)

4810 ONE-GROUP METHOD FOR FAST REACTOR CALCULATIONS. Sheaffer, M. K.; Driscoll, M. J.; Kaplan, I. (Massachusetts Inst. of Tech., Cambridge). Nucl. Sci. Eng.; 48: No. 4, 459-66(Aug 1972).

A one-group method for the calculation of neutron balances in

fast reactor cores is developed and evaluated. The key feature of the method is the definition of two spectrum characterization parameters in terms of spectrum-averaged one-group cross sections for the homogenized core composition: $S = \overline{\nu\Sigma_f}/(\overline{\nu\Sigma_f} + \overline{\xi_{el}\Sigma_{TR}})$ and $R = (S/1 - S)(\overline{\xi_{el}\Sigma_{TR}}/\Sigma_R)$, where ξ_{el} is the mean logarithmic energy decrement for elastic moderation and Σ_f, Σ_{TR}, and Σ_R are fission, transport, and removal cross sections, respectively. All required cross sections can then be correlated in the form $\bar{\sigma} = \sigma_1 S^g$ (where σ_1 and g are constants; one pair of values correlated for each cross section) except for threshold fission for which $\bar{\sigma} = \sigma_1 R^g$. A rapidly converging iterative procedure is presented through which S and R can be determined for any core composition. Microscopic cross-section data are correlated in the above form using the 26-group ABBN multigroup set as parent data. The one-group method is tested for 45 different fast reactor core compositions by comparing the results of the one-group calculations with those of 26-group calculations. The results are found to agree within an average error of ±1.77% in the material buckling or to ±0.69% in effective multiplication factor. One-group relationships are also developed for the calculation of prompt-neutron lifetime, Doppler reactivity, and other parameters of interest. 12 references. (auth)

4811 ANALYSES OF TEMPERATURE AND POWER NOISE IN OPERATING NUCLEAR REACTORS. Saito, Keiichi (Hokkaido Univ., Sapporo). Nucl. Sci. Eng.; 48: No. 4, 467-74(Aug 1972).

Lehto and Carpenter performed a set of experiments concerning the temperature and the gamma-ray fluctuations in a relatively low power reactor with high fission product inventories. The results are uniformly and quantitatively analyzed by applying the theoretical approach previously developed. The new features of the present consideration are the following two points: (a) incorporation of the external noise source in the previous theory which includes only the inherent noise source theoretically determined with the use of the first-order linearized Markoffian model of the reactor noise phenomenon; (b) analysis of the cross power spectral density (CPSD) between the two state quantities characterizing the core performances. The first point gives a successful interpretation of most of the experimental results in spite of adopting a simple analytical model. The newly extended framework of the theory can include also a reactivity transfer-function analysis with the use of a proper driving function. The phase of the CPSD between the power and the temperature is calculated on a one-space-point, a one-delayed-group, and a one- or two-feedback-loop reactor model. The results suggest that the experimental determination of the phase will provide both a check point for the theoretical model of the dynamical behaviors of at-power reactors and some bits of information on the feedback parameters. 21 references. (auth)

4812 ADJUSTMENT OF GROUP CROSS SECTIONS BY MEANS OF INTEGRAL DATA. I. THEORETICAL STUDY. Mitani, Hiroshi; Kuroi, Hideo (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 9: No. 7, 383-94 (Jul 1972).

A theoretical treatment is developed for the adjustment of group cross sections making use of integral data such as critical mass, reaction rate ratio and sample worth ratio obtained from various fast critical experiments. The method of least squares is the usual practice in such treatment. In the present case, however, the total number of integral data available is usually smaller than that of the group cross sections to be adjusted. To overcome this difficulty, the observation equations for applying the least squares treatment are established by using both integral and differential data. In such treatment, the correlation between group cross sections can be easily taken into account. General formulas are presented on two kinds of such correlation, one based on nuclear theory and the other due to relative measurements of the cross sections. The χ^2-test for the sum of squares of the residual is used as criterion to judge whether or not group cross sections carry systematic error. If systematic error exists, the sum of squares of the residual has a non-central Chi-square distribution. When the systematic error is included only in the group cross sections and not in the integral data, it is possible to remove this systematic error through use of the method of least squares. 21 references. (auth)

4813 TRANSPORT THEORY OF NEUTRON WAVE PROPAGATION BY EIGENFUNCTION EXPANSION METHOD. Yamagishi, Tomejiro (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 9: No. 7, 420-9(Jul 1972).

An eigenfunction expansion method is developed for the neutron wave propagation theory with a cut off cross section. The full and half range orthogonality relations for the eigenfunctions are derived, which are respectively applied to obtain an infinite space solution and the space eigenvalue formula. The formula is tried on some actual evaluations, and found to reduce considerably the laborious procedure required hitherto. The existence of marked interference phenomena between the discrete and the pseudo modes is demonstrated by numerical calculations performed on the solutions for graphite and beryllium. 22 references. (auth)

4814 METHOD FOR EVALUATING THE LOCAL VARIATION OF THE NEUTRON FLUX. Nishizawa, Yasuo; Motoda, Hiroshi (Hitachi, Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 7, 412-19(Jul 1972).

One method of evaluating the local variation of the neutron flux is described. By regarding the variations in nuclear reactors such as control rod motion, fuel shuffling and refueling as disturbances added to the material buckling, a one-group diffusion equation is solved using the perturbation theory in one-dimensional geometry. This method is applied to an inhomogeneous reactor, which has already been disturbed, where the disturbances are approximated by a number of square pulses small enough for the method to be applicable. Good results are obtained with this method for disturbances equivalent to a reactivity of several percent. Discussion based on several examples are presented on the errors introduced by larger disturbances. (auth)

4815 RESONANCE INTEGRAL AND ITS TEMPERATURE COEFFICIENT FOR FINITE $^{238}UO_2$ ROD. Fukai, Yuzo (Nippon Atomic Industry Group Co., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 9: No. 7, 406-11(Jul 1972).

The resonance absorption integral and its temperature coefficient for finite $^{238}UO_2$ rods with a density of 10 g/cm^3, radii of 0.2, 0.3, 0.5, 1.0, and 2.0 cm, and heights of 10, 20, and 50 cm are calculated by using the RICM code and collision probabilities derived by improving Carlvik's equation. It is found that assumption of infinite rod height underestimates the resonance integral and the coefficient by about 4.5 and 2.5%, respectively, in the case where the height is 10 cm and the radius 2 cm, if the finite cylinder is substituted by an infinite one of the same radius. By adopting an infinite cylinder with the same mean chord length as the finite one, however, substitution of the finite by infinite cylinder does not unduly affect accuracy. Next, the validity of the flat flux approximation in the axial direction of a finite cylinder is examined by using collision probabilities for a cylinder system divided along its axis into meshes of equal height. It is concluded that no correction is necessary for this approximation. (auth)

GENERAL

Energy Economics

Refer also to abstract 4457.

4816 (KFK–1616) ENERGY TRANSMISSION, ENERGY ACCUMULATION, AND LOW TEMPERATURE. Heinz, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Apr 1972. 49p. (In German). (CONF-720459–1). Dep. NTIS (U. S. Sales Only).

From Reactor conference; Hamburg, Germany (11 Apr 1972).

The energy consumption of the world is steadily increasing and may reach some unpredictable degree. In this respect the electrical energy and hereby the nuclear energy are of great importance. Site and cooling problems of power stations are steadily gaining in importance. The supply of the wanted energy cannot be considered only under an economical point of view but ecological and social aspects are coming more in the forefront. Power production in large units (nuclear parks) near cooling resources, together with a power supply system which fulfills widespread transport, reserve and distribution functions, could guarantee the future energy supply without intolerable environmental load of industrial complexes, large cities, and living centers. In this respect superconducting power transmission systems appear to be especially attractive, because of their modest dependence of power on cost. Technical problems and limits of conventional and superconducting technology are discussed; the state of art and an economical comparison of power transmission systems are given. (auth)

Law

4817 NUCLEAR LEGISLATION. de Narcy, B. (CEA, Paris). Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 94, 5-13(Mar 1972). (In French).

In France, nuclear legislation in various different fields (industrial and commercial establishments manufactoring, utilizing or storing radioactive substances; radioactive wastes; radiation hazards; protection of workers from ionizing radiations) is based on common law. Ionizing radiation risks are considered on the same basis as other professional risks as far as the French Social Security is concerned. Nevertheless, special legislation has been established in the following fields: creation of basic nuclear installations (necessary authorization); preparation and use of artificial radioisotopes (medical and industrial applications); protection against radiations; civil responsibility of the users of nuclear installations. The modifications likely to be made to existing legislation and recently drafted legislation (radioactive waste disposal, protection of workers in basic nuclear installations) are discussed together with legislation in foreign countries advanced in the field of nuclear engineering. (France)

Management

4818 (NP–19461) REPORT AND ACCOUNTS OF THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY FOR THE YEAR ENDED 31st MARCH 1972 TOGETHER WITH THE COMPTROLLER AND AUDITOR GENERAL'S REPORT ON THE ACCOUNTS. Eighteenth Annual Report, 1971–72. (United Kingdom Atomic Energy Authority, London (England)). Oct 1972. 86p. Dep. NTIS (U. S. Sales Only).

Chapters cover different aspects of the work of the UKAEA: general survey of the main tasks during the period under review and of changes in organization and administration; electricity generation–reactor development (gas-cooled reactors, including AGR and HTGR types, steam generating heavy water reactors and sodium-cooled fast reactors, systems studies of thermal and fast reactors and of longer term developments, underlying research in support of reactor development); fusion research; industrial applications and services in the nuclear energy field; industrial applications and services outside the nuclear energy field but based on the expertise built up in the UKAEA (including a wide range of topics such as tribology, non-destructive testing, heat transfer and fluid flow, desalination, extrusion, ceramics, carbon fibers, fuel cells, electrotechnology, environmental research); health and safety; external relations; finance and administration. (UK)

Mathematics and Computers

4819 (UCRL–20096) USE OF INTERACTING COMPUTING AT LAWRENCE BERKELEY LABORATORY. Colonias, J. S. (California Univ., Berkeley. Lawrence Berkeley Lab.). Aug 1971. Contract W-7405-eng-48. 38p. (CONF-701102–25). Dep. NTIS.

From Meeting of the American Nuclear Society; Washington, D. C. (15 Nov 1970).

During the past few years there has been a considerable amount of hardware and software development in the area of graphic display interaction. This relatively new mode of operation has received considerable attention as evidenced by the fact that most major computing installations are either seriously investigating this area or presently have access to such devices for scientific computation. Graphic display interaction radically departs from the conventional mode of batch processing, and it offers very attractive features particularly suited to research-type calculations. In this mode, the user is no longer a passive observer tacitly accepting the idiosyncrasies of his computational device, but rather, a dynamic member of the computational loop directing the progress of his problem solution at his discretion. This paper describes the Laboratory's contributions in this area and the progress made in applying graphic and interacting techniques to the solution of problems in nuclear physics. A description of the existing computer environment is followed by one of the software developed to implement the graphic display and interacting mode of operation and some of the prominent interacting programs. The first program, TRANSPORT, allows the experimenter to design beam transport systems; that is, the transformation that a beam of charged particles undergoes as it passes a series of magnets and lenses. The desirability and importance of graphic displays is demonstrated; and the interacting process, as applied to the solution of this type of problem, is shown to be an indispensable tool in the better understanding of the behavior of beam transport systems. The second program, TRIM, is used to design magnets for particle accelerators. Here, also, the graphic displays play a very important role in understanding the behavior of magnetic fields and allow the experimenter to investigate various magnet models, analyze the resulting magnetic fields, alter their geometries, and, in general, investigate alternative designs to arrive at the desired magnetic field. (auth)

Miscellaneous

4820 (ACRH–1000-387) DIAGNOSTIC EVALUATION AND CLINICAL STAGING IN HODGKIN'S DISEASE. Usefulness and Problems of the Ann Arbor Staging Classification in Primary Staging and Staging in Relapse. Ultmann, J. E.; Moran, E. M. (Chicago Univ., Ill. Pritzker School of Medicine. Argonne Cancer Research Hospital, Chicago, Ill.). [nd]. 20p. Dep. NTIS.

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4823 (ANL/ES–13) TIME-SHARING ISOPLETH-AREA PROGRAM. King, R. F. (Argonne National Lab., Ill.). Sep 1972. Contract W-31-109-eng-38. 35p. Dep. NTIS.

4824 (BNL-tr–496) FORMATION OF REACTION CENTERS IN THE THERMAL DECOMPOSITION OF ORTHORHOMBIC AMMONIUM PERCHLORATE AND THE ROLE OF DISLOCATIONS IN THIS PROCESS. Raevskii, A. V.; Manelis, G. B. Translated by S. J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from Third All-Union Symposium on Combustion and Explosion, Leningrad, July 1971. 13p. (CONF-710732–1). Dep. NTIS.

4825 (BNWL–B–173) HANFORD WELL WATER TEMPERATURE LOGGING SYSTEM. Tillson, D. D. (Battelle

Pacific Northwest Labs., Richland, Wash.). Apr 1972. Contract AT(45-1)-1830. 13p. Dep. NTIS.

4826 (CEA-CONF-2084) USE OF FREONS IN HEAT PUMP CIRCUITS: HEATING OF ARGYRONETE BY A HEAT PUMP. Lavigne, P.; Martin, R.; Chevrier, C.; Gouzy, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [nd]. 9p. (In French). (CONF-720648-24). Dep. NTIS (U. S. Sales Only).
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From 65th annual meeting of the American Institute of Chemical Engineers; New York, NY. (26 Nov 1972).

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4858 (ITF-72-86-P) STRUCTURE OF THE BANDS OF LIGHT ABSORPTION BY CRYSTALS IN EXCITONIC REGION. Lubchenko, A. F.; Tkach, N. V.; Nitsovich, V. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1972. 26p. (In Russian). Dep. NTIS (U. S. Sales Only).

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